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OPERATING INSTRUCTIONS

FOR THE

SIGNAL GENERATOR
TYPE 202-G FM-AM

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

2/57

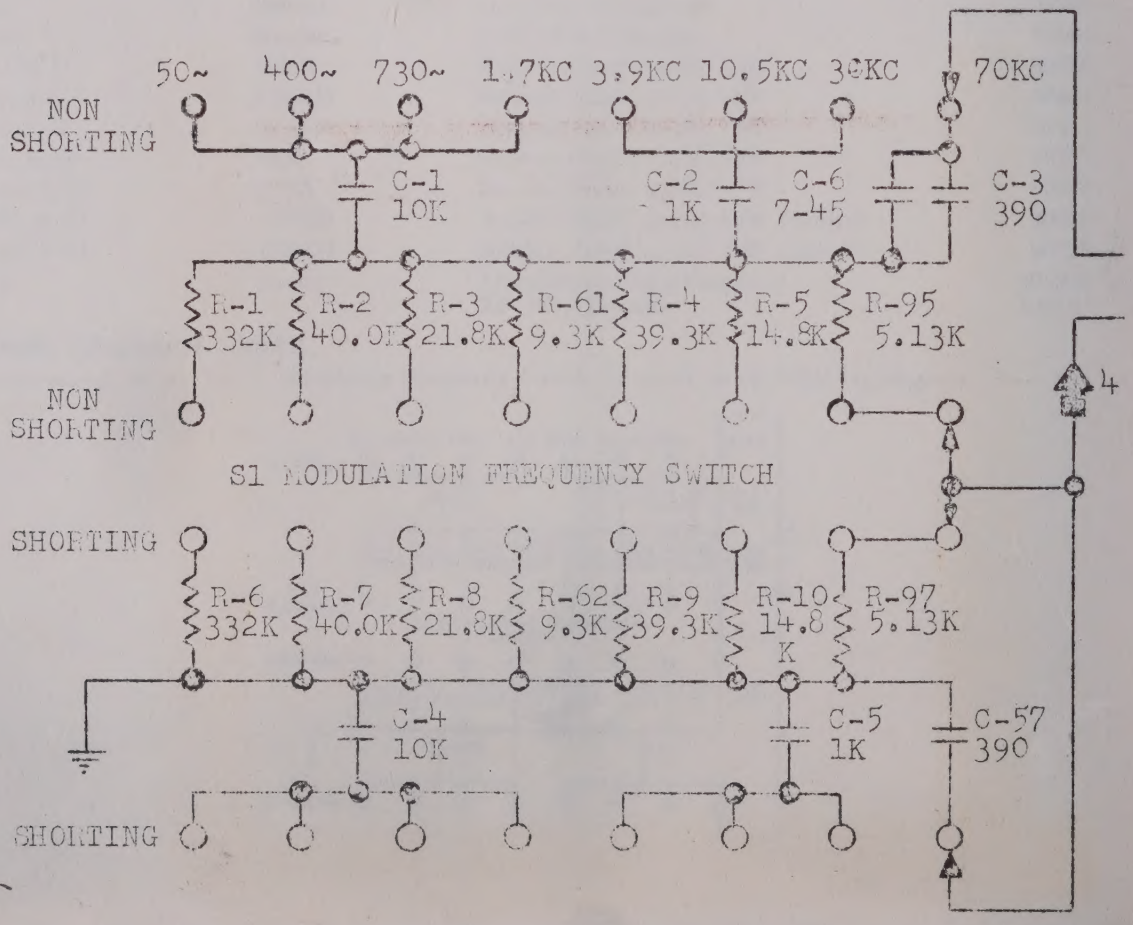
Printed in U.S.A.

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY

INSTRUCTION BOOK CHANGE NOTICE
TYPE 202-G FM-AM SIGNAL GENERATOR

The following changes, affecting the instruction book and the attached Addendum, have been made in the Type 202-G FM-AM Signal Generator. The corrected Modulation Frequency Switch connections are shown below.

Ref. Symbol	Description of Change	BRC Part No. Old	New
C3, C57	Replaced one 970 $\mu\mu$f capacitor with two 390 $\mu\mu$f capacitors	82248	82220
R15	Changed from 150 ohms to 240 ohms	80098	80114
R16	Changed from 33k ohms to 3.9k ohms	80461	80287
R96, R98	Deleted	80229	
P2	Voltage at prong 3 corrected from +265 to +240 volts		



THIS IS BOOK NO. 4

2507

TRAINING SECTION
INDUSTRIAL R LATIONS DEPT
AERO-SPACE DIVISION

FOREWORD

This manual contains two sets of instructions, one for the 202-F Signal Generator and the other for the 207-F Univerter. Both sets are complete in themselves. However, since the 207-F is not a signal generator but a frequency converter designed for use with the 207-F, it was decided to place both manuals between the covers of one instruction book.

An appendix is included at the end of the book describing the accessory matching pads used with the 202-F alone or in conjunction with the 207-F Univerter.

Both instruments can be rack mounted, if desired as shown in Figure 1 of the 202-F Manual.

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TYPE 202-F FM-AM

BOONTON RADIO CORPORATION
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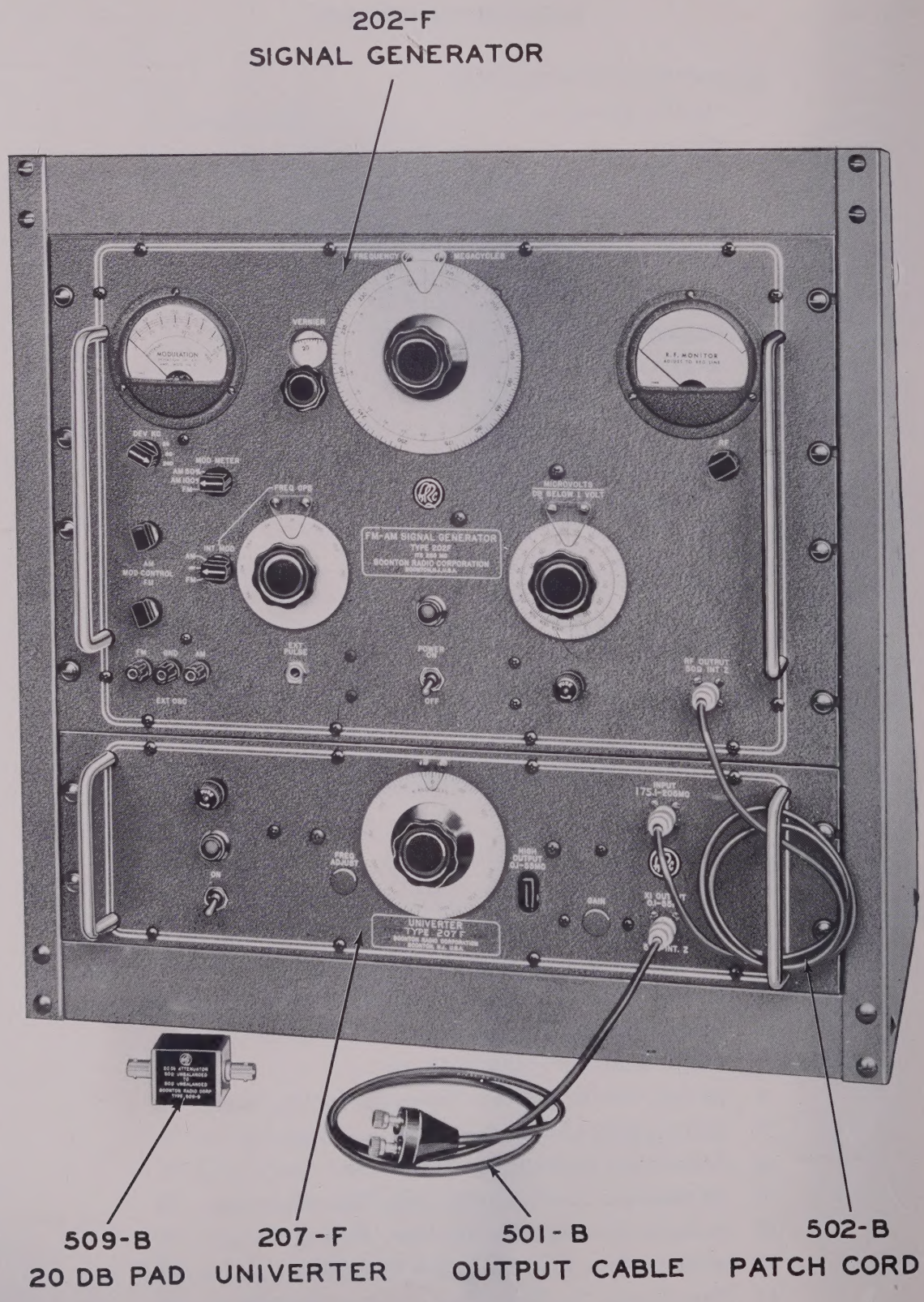


Fig. 1 Rack Mounted View of FM-AM Signal Generator 202-F and Accessory Univerter 207-F

I. INTRODUCTION

GENERAL

The Type 202-F Frequency Modulated Signal Generator has been developed to meet the specialized requirements of engineers working with telemetering receivers and other associated equipment. It is a precise and reliable instrument for rapidly evaluating overall system performance. Provisions have also been made whereby it may be used in this frequency range as an amplitude modulated RF signal source or, in conjunction with an external audio oscillator, may be used to produce a signal having simultaneous FM and AM.

Physically this instrument consists of four major subassemblies: (1) panel assembly, (2) RF assembly, (3) audio oscillator, and (4) regulated power supply.

The RF unit is secured to the rear of the front panel while the audio oscillator and power supply are fastened to the sides of the generator cabinet and are electrically connected to the front panel and RF assembly by means of cables and plug connectors.

The cabinet is so designed that the unit may be used as bench type equipment or quickly converted for mounting in a standard 19 inch rack.

Meters and calibrated controls are direct reading and, with all other operating controls, are located according to function on the front panel.

The wiring and layout of the various components have been arranged for best performance and maximum simplicity, resulting in a compact unit of moderate size. For convenience in carrying and protection of the front-panel controls, two utility handles have been provided on the front panel.

This instrument is supplied complete with tubes, instruction manual, and RF Cable Type 501-B.

BASIC OPERATING PRINCIPLES (Fig. 2)

Figure 2 shows in block form the basic elements employed in the 202-F Signal Generator. A type 6C4 triode is used as an RF oscillator and is tuned over the frequency range of 43.75-62.50 megacycles.

Coupled to the RF oscillator is a 6AK5 reactance tube which for frequency modulation, shifts the frequency of the oscillator in direct proportion to the instantaneous audio voltage applied to the reactance tube from the audio modulating oscillator.

The output from the RF oscillator is fed to a Class C frequency doubling stage which is tuned to the second harmonic of the oscillator frequency, thus covering a frequency range of 87.5-125.0 megacycles. Following this doubling stage is an output stage which also serves to double the frequency of the incoming signal with a resultant output frequency of 175-250 megacycles. Amplitude modulation is obtained at this output stage by applying a modulating voltage to the screen of the 6AK5 tube.

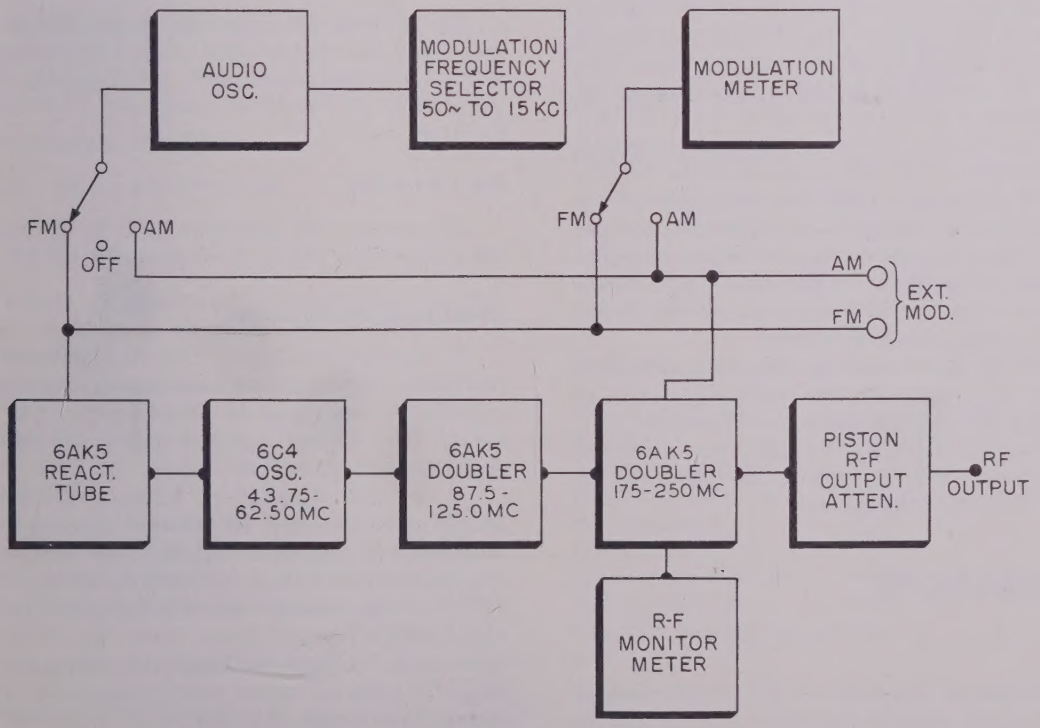


Fig. 2 Basic Elements of 202-F FM-AM Signal Generator

Coupled to the plate inductor of the output stage is a piston type mutual inductance attenuator having a 50-ohm resistor in series with the one turn coupling loop.

The dial of the attenuator is calibrated in (a) microvolts and (b) decibels below 1 volt, in terms of the voltage present at the output cable terminal posts when the power output from the last stage is set to the proper level as indicated by the output monitor meter.

The 50-ohm RF output cable is terminated at one end by a 50-ohm resistor and terminal post assembly and at the other end by a BNC type connector which attaches to the RF panel jack. The output impedance of the generator with this cable connected is 25 ohms. The voltage appearing across the output cable terminal posts is read directly on the output attenuator dial.

PRELIMINARY INSTRUCTIONS

The instrument should be carefully removed from the packing carton. Connect the power cord to a suitable 115 volt, 50-60 cycle outlet. Operate the Power Switch to the "ON" position. Attach the 501-B Output Cable to the front panel RF Output Jack by pushing in on the cable connector and rotating it clockwise.

Operation of the RF Monitor Control should cause the pointer of the RF Monitor Meter to move. It should be possible to set the meter pointer to the red reference mark over the entire frequency range from 175-250 megacycles. This is an indication that the RF oscillator and amplifiers are working properly.

To check the FM and AM modulating systems, turn the Modulation Selector Switch to FM, the Modulation Meter Switch to FM, and the Deviation Range Switch to 24 kc., 80 kc., or 240 kc. Operating the FM Deviation Control in a clockwise direction should cause the Modulation Meter to read increasing deviation. Switch the Modulation Selector Switch to AM, the Modulation Meter Switch to AM 50%, and rotate the Amplitude Modulation Control clockwise. The Modulation Meter should read the degree of amplitude modulation present and full-scale setting should be possible. With the Modulation Meter Switch in the AM 100% position a maximum Modulation Meter setting of approximately ½ scale should be possible.

To prepare this instrument for rack mounting it is necessary only to, (1) remove the externally available screws securing the two end-bells to the cabinet, (2) remove the end-bells exposing the rack mounting holes in the front panel, and (3) remove the four rubber feet from the bottom of the cabinet.

II. SPECIFICATIONS

RF Range

Overall frequency coverage of 175 to 250 megacycles in one range, accurate to within ±0.5% after a warm-up period of one hour. The main frequency dial is also marked in 24 equal divisions for use with the vernier frequency dial.

Vernier Frequency Dial

The vernier frequency dial is divided into 100 equal scale divisions and is mechanically coupled to the main frequency dial by a 24:1 gear train, providing about 2200 logging divisions over each frequency range. The approximate frequency change per vernier division is 35 kc.

RF Output Voltage

The maximum open circuit output voltage from the BNC type RF output jack at the front panel is about 0.4 volt. With the standard output cable (type 501-B) attached, the maximum calibrated output voltage at the cable terminals is nominally 0.2 volt. When the RF monitor meter is set to the red calibration line and the standard output cable attached, the RF output attenuator (which provides two dial scales) is (a) direct reading in microvolts and continuously adjustable from 0.1 microvolt to 0.2 volt, and (b) direct reading in decibels below 1 volt and continuously adjustable from 140 decibels to 14 decibels.

RF Output Impedances

The RF output impedance of the signal generator as seen looking into the BNC type front panel connector is 50 ohms. With the standard output cable attached, the RF output impedance as seen looking into the output cable terminals is 25 ohms.

Frequency Modulation

Three frequency deviation ranges 0-24 kc, 0-80 kc, and 0-240 kc are provided, each continuously adjustable. Calibrated increments are 1 kc on the 24 kc range, 5 kc on the 80 kc range, and 10 kc on the 240 kc range.

FM Distortion

The overall FM distortion at 75 kc deviation is less than 2%, and at 240 kc is less than 8%.

Amplitude Modulation

1. 0-50% Modulation: Utilizing the internal audio oscillator, or an external modulating oscillator, amplitude modulation may be obtained over the range of 0-50%, with meter calibration points provided at 30% and 50% modulation points.
2. 0-100% Modulation: Using an external modulating oscillator, the RF carrier may be amplitude modulated to substantially 100%. For this purpose the modulation meter has a scale calibration point at 100%.
3. Pulse Modulation: A front panel jack is provided which permits direct connection of an external modulation voltage source to the screen of the final stage for pulse or square wave modulation. When this connection is made the modulation meter and internal circuits are disconnected from the screen element. Approximately 75 volts is required to maintain the carrier at its normal level and about minus 3 volts will

shut the carrier off.

AM Distortion

The distortion present at the RF output is less than 3% at 30% modulation and less than 6.5% at 50% modulation. Distortion is 12% to 15% at 100% modulation, depending upon the modulating frequency.

Fidelity Characteristics

The deviation sensitivity of the FM modulation system as a function of frequency is flat within ±1 db from 30 cps to 200 kc.

The amplitude modulation system, with the modulation potentiometer at maximum position, is flat within ±1 db from 30 cps to 200 kc. With the modulation potentiometer at one half of full rotation, the amplitude modulation system is flat within ±1 db from 30 cps to 70 kc.

Direct connection to the screen element of the final output stage permits square wave or pulse modulation voltage to be applied from an external source. Under these conditions the rise time of the modulated carrier envelope is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

Spurious RF Output

All spurious output voltages are at least 25 db below the desired fundamental.

Signal-to-Noise Ratio

Total RMS spurious FM from the 60 cycle power source is down more than 50 db, with 75 kc. deviation as a reference level.

Carrier Frequency Stability

0.04%/hr. after 1 hour warmup.

Internal AF Oscillator

The internal AF oscillator may be switched to provide either frequency or amplitude modulation; it may also be switched off.

The internal AF oscillator provides eight fixed frequencies which may be selected by a rotary switch, — 50, 100 and 400 cycles, and 1, 5, 7.5, 10 and 15 kc, accurate to with 5%. Harmonic distortion, in general, is less than 0.5%.

The output of the internal oscillator is available (at the external binding posts) for synchronizing or other applications if desired. Approximately 5 V on the FM posts and 50 V on the AM posts are available.

External Modulation Requirements

1. Frequency Modulation.

Approximately 4.8 volts required for full scale modulation. For external FM the input impedance is approximately 1500 ohms.

2. Amplitude Modulation.

Approximately 45 volts is required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is approximately 7500 ohms shunted with 1000 mmf.

Simultaneous Modulation

For certain tests simultaneous FM and AM is sometimes desired. The 202-F FM-AM Signal Generator, in combination with an external low distortion modulating oscillator, may be used for this purpose provided that the modulating oscillator is capable of developing approximately 4.8 volts across a 1500 ohm load, the FM requirement for 240 kc deviation.

In use the external modulating oscillator is connected to the FM external binding posts, the modulation selector switch set to AM, and the levels of each type of modulation independently set on the modulation meter by operation of the modulation meter switch, FM deviation control, and amplitude modulation control.

CAUTION:

Use of an external audio oscillator for AM, with the INTERNAL MODULATION OSCILLATOR switched to FM, will result in interaction between modulation circuits when both oscillators are operating at or near the same audio frequency.

Simultaneous FM at two modulation frequencies or simultaneous AM at two modulation frequencies is also possible. In practice the external modulating oscillator is connected to the pair of external binding posts which are marked to correspond with the setting of the internal modulation selector switch.

Power Requirements

The 202-F FM-AM Signal Generator is designed for use with 115 volts, 50-60 cycles. It will operate satisfactorily, however, over a voltage range from 105-125 volts without changing the RF frequency by more than 0.05%. Power consumption is 65 watts.

Tube Complement

Audio Oscillator	6AU6, 6V6GT/G	(V1, V2)
Rectifier	5Y3GT/G	(V3)
Voltage Regulator	OD3/VR-150	(V4)
Reactance Modulator	6AK5*	(V5)
RF Oscillator	6C4*	(V6)
Doubler Stage	6AK5*	(V7)
Doubler and Output	6AK5*	(V8)
Ballast Resistor	6H-6	(R16)

*Specially Selected. See parts list.

Dimensions

L — 19¼" W — 12 5/16" Depth — 10⅞"

Weight Generator 41 lbs.

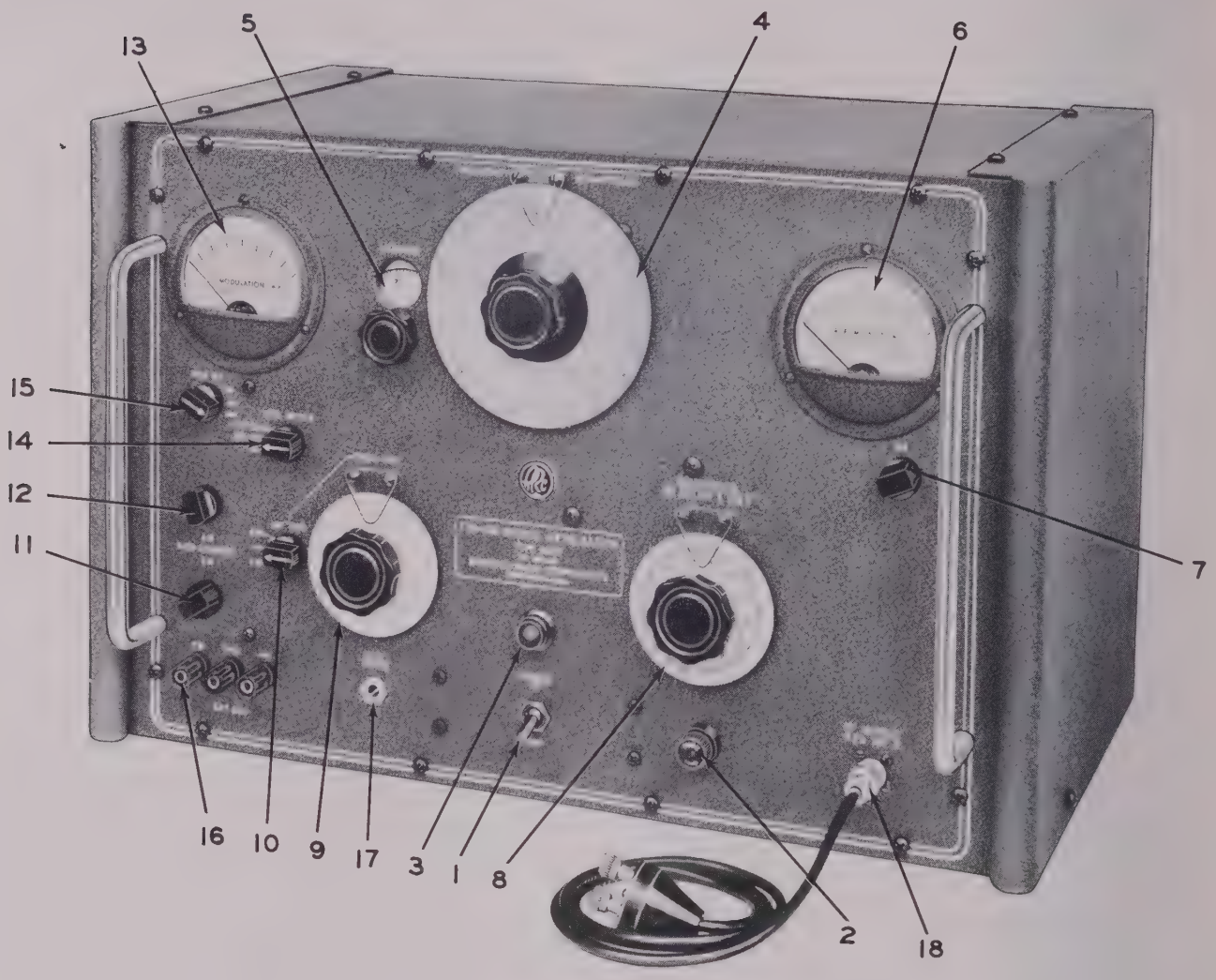


Fig. 3 Front Panel Controls and Layout

III. OPERATING CONTROLS

SIGNAL GENERATOR (Fig. 3)

1. Power Switch

This switch applies power to the circuits when in the "ON" position.

2. Fuse

One fuse is provided in the power transformer primary, to protect the instrument. It is replaceable from the front panel.

3. Pilot Lamp

A red lamp, which when lit indicates that the circuits are energized. The bulb is replaceable from the front panel.

4. Main Frequency Dial

The Main Frequency Dial is calibrated from 175 to 250 megacycles. An inner scale is divided into 24 equal divisions for use with the Vernier Frequency Dial.

5. Vernier Frequency Dial

This dial is divided into 100 divisions and is coupled to the Main Frequency Dial through a 24:1 gear train, providing a total of approximately 2200 logging divisions for the tuning range.

6. RF Monitor Meter

The RF Monitor Meter is used to standardize the power level of the last r-f amplifier stage. In operation the meter pointer is set to the red calibration line on the meter scale.

7. RF Monitor Control

This adjustment sets the RF Monitor Meter to the proper reference level such that the output attenuator calibration is direct reading.

8. RF Output Attenuator

The RF Output Attenuator Dial is calibrated directly in (a) microvolts and (b) decibels below 1 volt output at the 501-B Output Cable terminals. It is standardized by setting the pointer of the RF Monitor Meter to the red calibration mark on the meter scale.

9. Modulation Frequency Switch

This control selects any one of eight fixed audio frequencies between 50 cycles and 15 kilocycles for either frequency or amplitude modulation.

10. Modulation Selector Switch

This switch connects the internal modulating oscillator for either frequency modulation or amplitude modulation. The OFF position disables the oscillator.

11. FM Deviation Control

A continuously variable control for adjusting the frequency deviation on any of the three ranges 0-24 kc, 0-80 kc, or 0-240 kc.

12. Amplitude Modulation Control

A continuously variable control for adjusting the amplitude modulation level when either the internal AF oscillator or an external modulating oscillator is used.

When high modulating frequencies from an external source are employed, the frequency response is improved by keeping the Amplitude Modulation Control at full clockwise rotation and adjusting the Modulation Meter reading at the external source (see Specifications).

13. Modulation Meter

The Modulation Meter has four scales providing three FM deviation ranges and two amplitude modulation ranges: 0-24 kc deviation in 1 kc increments, 0-80 kc deviation in 5 kc increments, 0-240 kc deviation in 10 kc increments, 0-50% amplitude modulation, with calibration marks at 30% and 50%, and 0-100% amplitude modulation with a calibration mark at 100%. The 100% scale is for use only when an external modulating oscillator is employed.

14. Modulation Meter Switch

By means of this control the Modulation Meter may be switched to either the FM or AM modulating system to indicate the degree of modulation present. The FM and AM 50% positions are for use with either internal or external modulating oscillator. The AM 100% position is for use only when an external modulating oscillator is employed.

15. Deviation Range Switch

This rotary type switch selects three modulation meter FM deviation ranges, 0-24 kc, 0-80 kc, and 0-240 kc.

16. External Oscillator Binding Posts

These posts provide a means whereby an external source of modulating voltage may be applied to the instrument.

The output voltage of the internal oscillator is available at the external binding posts for synchronizing or other purposes.

17. Pulse Modulation Jack

The Pulse Modulation Jack is provided to permit direct connection of an external modulation voltage source to the screen of the final stage for pulse or square wave modulation. When this connection is made the modulation meter and internal circuits are disconnected from the screen element.

18. RF Output Jack

This BNC type connector makes available for use the generator RF signal.

IV. THEORY OF OPERATION

REACTANCE MODULATION CIRCUIT

A 6AK5 tube (V5) operating as an inductive element across the tank circuit of the 6C4 (V6) oscillator circuit is employed for reactance modulation. In order to maintain constant frequency deviation sensitivity over the entire tuning range of the instrument, the amount of inductance injected by V5 is made to vary directly as the carrier frequency. This is accomplished by a bridged tee network consisting of R43, R44, C33, the grid plate capacitance of V5, and the grid cathode capacitance of V5. Although this circuit arrangement is capable of producing fairly constant deviation with fixed components, C33 is made variable and ganged with the oscillator tuning condenser to provide the precision of deviation calibration required in a signal generator.

Resistor R50 serves to bleed the proper amount of current through R46, R47 to permit operation of V5 over the most linear portion of its characteristics (Fig. 14).

The cathode resistors R46 and R47 which provide bias for V5 are bypassed by C34 for radio frequencies only and degeneration takes place at audio frequencies. Resistor R47 is used to adjust the amount of degeneration present in order to provide the desired deviation sensitivity.

Switch S3 reduces the modulating voltage applied at the reactance tube to one third when operated from the 0-240 kc deviation position to the 0-80 kc deviation position, and to one tenth when operated from the 0-240 kc deviation position to the 0-24 kc deviation position.

For FM, an audio modulating voltage is applied directly to the grid of V5, the reactance tube, through an RF filter which prevents stray RF currents from leaking out of the shielded portion of the instrument.

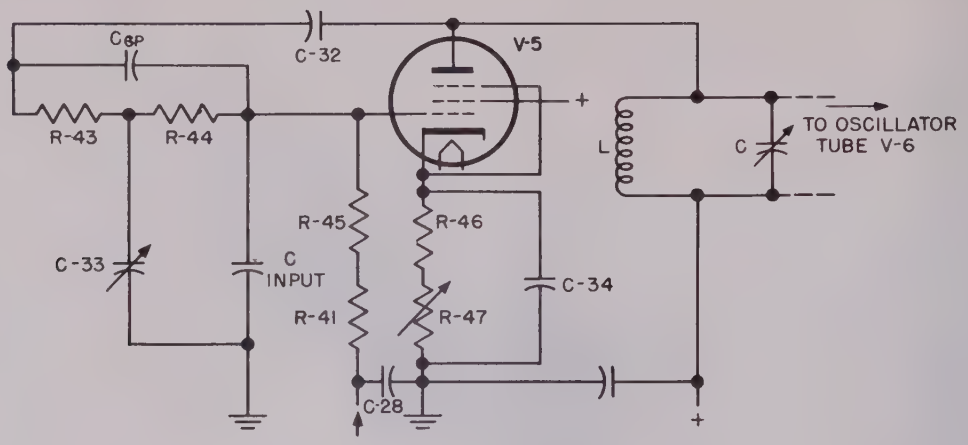


Fig. 4 Basic Reactance Modulator Circuit

RF OSCILLATOR (Fig. 14)

A tuned plate RF oscillator covers the frequency range from 43.75 to 62.50 mc. Tuning over this range is accomplished by means of capacitor C39 which is ganged to the two other variable tuning capacitors C45 and C50. The plate of V6 is normally operated at about 150 volts DC.

AMPLIFIER DOUBLER STAGE (Fig. 14)

A frequency doubling stage (V7) follows the oscillator and serves the two-fold purpose of (1) permitting the oscillator to be operated at a lower frequency and (2) providing the desired isolation between oscillator and output stage to improve frequency stability. A further advantage is that it provides sufficient drive to saturate the output stage and thus remove any spurious amplitude modulation up to this point. This stage is self-biased and is arranged to track with the oscillator.

OUTPUT STAGE (Fig. 14)

The output stage employs a 6AK5 tube operating as a Class C doubler. The Q of the tank circuit has been selected to reduce spurious signals by more than 35 db and at the same time keep amplitude modulation to about 2% at 15 kc deviation.

Amplitude modulation is obtained by modulating the screen element of V8, sufficient isolation from the DC supply having been provided by the 50-henry choke, L2.

Capacitors C-29, C-30 and C-31 associated with the filter net-work for the screen lead of V8 have been kept as small as possible in order to provide greatest possible high frequency response for the AM system.

OUTPUT ATTENUATOR

A piston type RF output attenuator having an internal impedance of 50 ohms is inductively coupled to the tank circuit inductor of the final stage. The pick-up loop of the attenuator is continuously adjustable along the axis of the attenuator tube by means of a rack and pinion drive.

The RG58A/U output cable and BNC panel fittings are of 50 ohm impedance and the output cable is terminated by a 50 ohm carbon film resistor.

Figure 5 shows the basic design of the output attenuator system. The voltage induced in the attenuator coupling loop L20 in Figure 5a is:

It can be seen from Figure 5b that the voltage e across the terminating resistor is:

$$e' = I\omega M = \frac{E}{\omega L_{19}} \times \omega K \sqrt{L_{19} L_{20}} = EK\sqrt{\frac{L_{20}}{L_{19}}}$$

where $\omega = 2\pi$ times the frequency, K is the coefficient of coupling between L_{19} and L_{20}, and M is the mutual inductance between L_{19} and L_{20}.

This equation shows that e′ is a function of the tank voltage E and the coefficient of coupling K only. K is controlled by the attenuation law of the piston attenuator while E is monitored by the output monitor meter.

$$e = \frac{50\ e'}{100 + j\ (\omega L_{20})} = \frac{50\ e'}{\sqrt{(100)^2 + (\omega L_{20})^2}}$$

Since L_{20} is less than 0.01 microhenry, $(\omega L_{20})^2$ can be neglected in comparison with $(100)^2$ and:

$$e = \frac{e'}{2}$$

Neglecting L_{20} in Figure 5b, an application of Thevenin's theorem yields the equivalent circuit shown in Figure 5c. Thus the generator can be represented as a source voltage e in series with a resistance of 25 ohms. The attenuator dial is calibrated in terms of the open circuit output voltage e (Fig. 5c) and is direct reading in microvolts from 0.1 microvolt to 0.2 volt when the output monitor meter is set to the red reference line.

If the load impedance is not large compared with ohms, the voltage applied to a load connected at the output terminals can be calculated by using the equivalent circuit of Figure 5c.

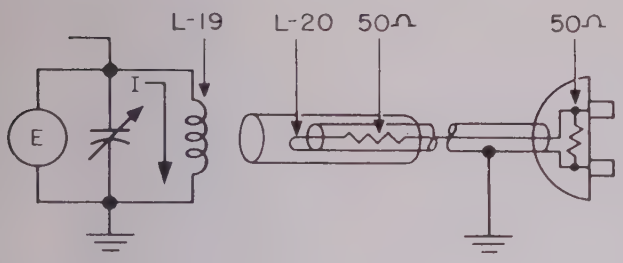


FIG. 5a

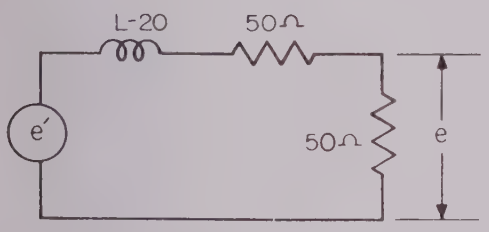


FIG. 5b

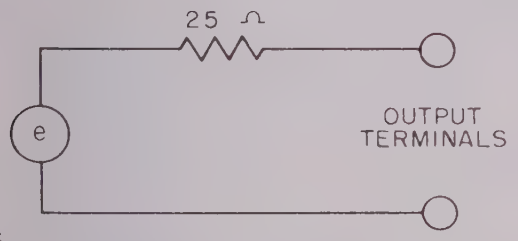


FIG. 5c

Fig. 5 Output Attenuator Equivalent Circuit

AF OSCILLATOR (Fig. 14)

The AF oscillator employed is quite free from distortion having, in general, total harmonic content of less than 0.5%. The conventional Wein bridge type of R-C oscillator is used. The series and shunt R-C combinations required to provide the desired modulating frequencies are mounted directly on the rotary type selector switch and are connected by means of two leads to the AF chassis which mounts the oscillator tubes and components. Approximately 50 volts is available from the plate of the 6V6 tube (V2) for modulating purposes, the exact value being controlled by adjustment of R-12 which regulates the amount of negative feedback voltage applied to the cathode of V1.

PULSE MODULATION (Fig. 14)

Pulse Modulation Jack J-1 provides a means for introducing an external voltage source to pulse or square wave modulate the r-f carrier. When this connection is made the modulation meter and internal circuits are disconnected from the screen. Resistor R-26 is in series with the screen lead to damp out any transients which might otherwise occur.

POWER SUPPLY (Fig. 14)

The high voltage supply provide +265 V unregulated and +150 V regulated by a VR-150 voltage regulator tube. Resistor R19 is adjusted at the factory to keep the current through the regulator tube within the limits of 5 to 40 milli-amperes when the line voltage is varied from 105 to 125 volts and with the signal generator adjusted for normal operation.

V. MAINTENANCE INSTRUCTIONS

OPENING INSTRUMENT

The following procedure allows access to the instrument interior.

Remove the end bells (if the instrument is used in rack mounting this will already have been done, p. 8).

For access to the rear of the instrument remove the available screws at edge of rear panel. Remove rear panel.

For more complete access to the instrument proceed as follows: Remove the screws along the engraved line near the panel edge. Move the panel forward from the cabinet a few inches to allow separation of the power supply unit and audio oscillator unit cable connectors at rear of panel. Separation of the connectors allows the panel assembly and cabinet assembly to be separated.

RF UNIT (Fig. 6)

This unit has been carefully adjusted and calibrated at the factory to meet the specifications listed in this instruction book. Specialized testing equipment and procedures are required which make field adjustments and replacements in the unit difficult and undesirable. For this reason, if any troubles are believed to have developed in the RF Unit, the Signal Generator should be returned to the factory for repair and readjustment, with the factory warranty being voided if our inspection shows damage or maladjustment caused by the customer.

The 60 cycle heater voltage between pin 5 of power supply socket and ground (Fig. 8) should measure 6.8 volts. If the RF unit is found to be inoperable and this voltage measures in the vicinity of 9 volts, the trouble is probably due to an open heater circuit at one of the RF tubes. Continued operation of the instrument under this condition will damage the other RF tubes.

AMPLITUDE MODULATION ADJUSTMENT

If desired, the degree of amplitude modulation indicated by the modulation meter can be checked by suitably mixing the output of the generator with another signal source such that a difference frequency of approximately 100-150 kc is produced. This difference frequency can be observed visually on a cathode ray oscilloscope and used for adjustment purposes. To change the modulation meter AM sensitivity to agree with that degree of modulation present, adjust R35 (Fig. 8) for the AM 50% range and R21 for the AM 100% range.

FREQUENCY MODULATION ADJUSTMENT

The 6AK5 reactance modulator tube contained

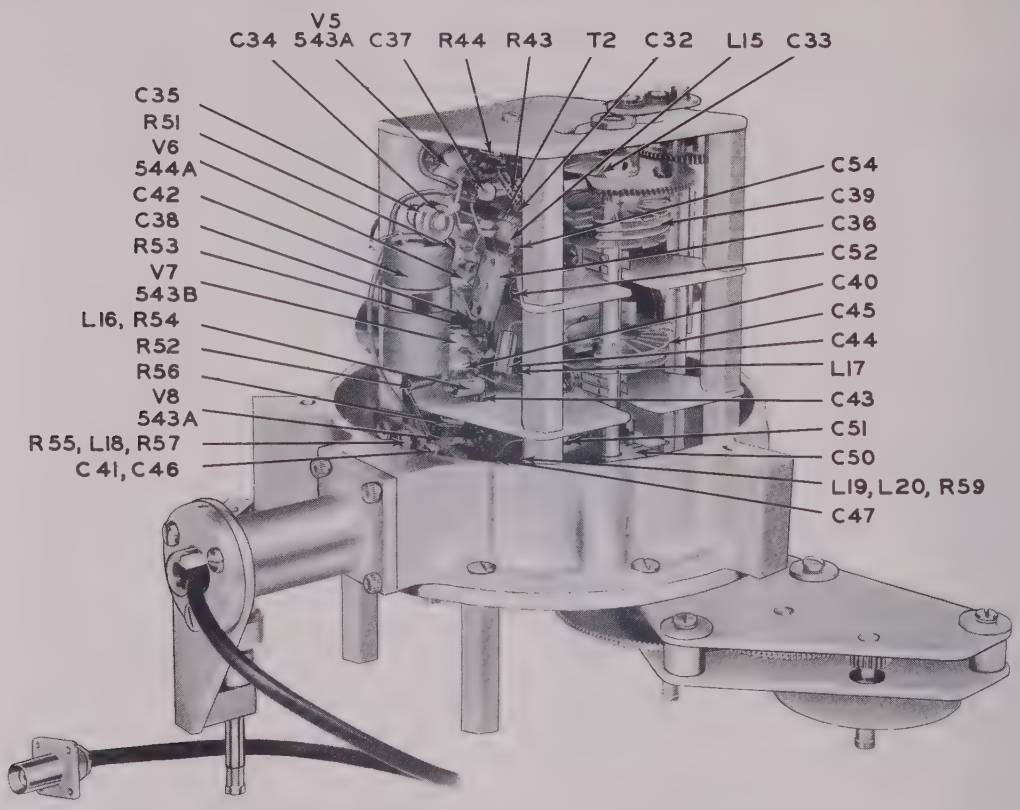


Fig. 6 RF Unit, Left Oblique, Cover Removed

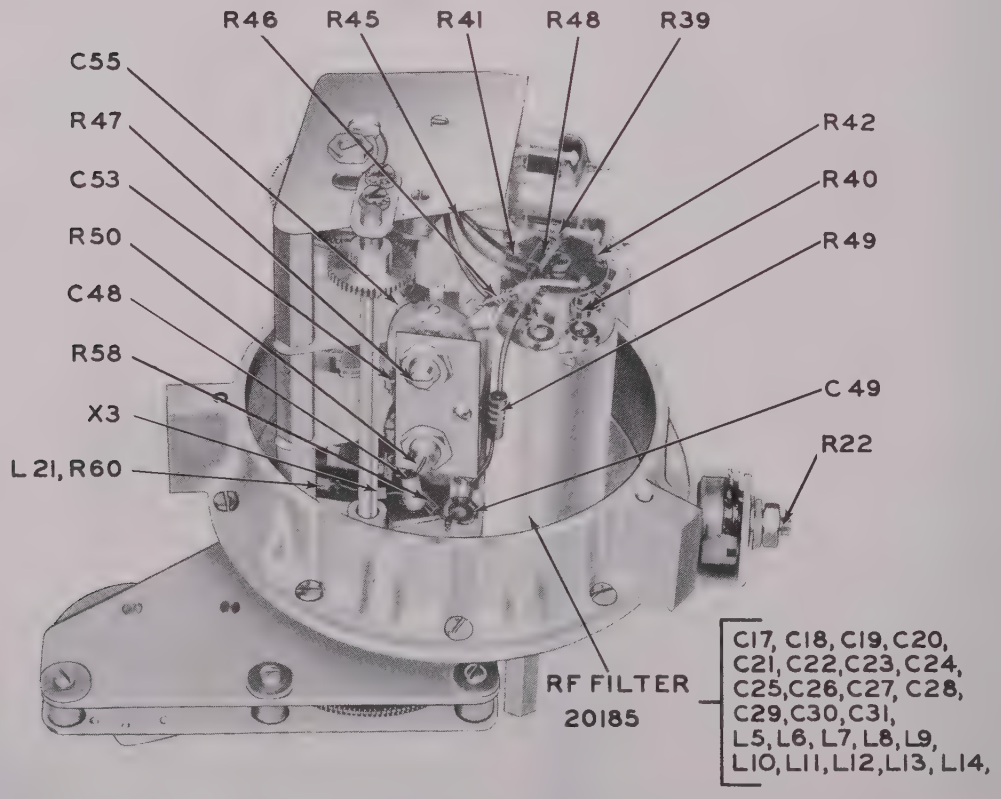


Fig. 7 RF Unit, Right Oblique, Cover Removed

within the sealed RF unit has been carefully adjusted for a generator output frequency deviation sensitivity of 16.67 kc per volt RMS measured at the center terminal of the FM deviation control pot R-31 with the deviation range switch set at the 80 kc position.

If for any reason it is desired to check the carrier deviation, this may be accomplished using a Crosby* or carrier zero method of measurement.

A selective communications superheterodyne receiver tuned to the RF output of the generator can be used as a null indicator to determine the exact point at which the carrier current disappears.

Since the modulation index B is defined as the ratio of the frequency deviation ΔF to the modulating frequency f, or

$$B = \frac{\Delta F}{f}$$

the frequency deviation is given by:

$$\Delta F = B \times f$$

The carrier will reach its minimum value at the following modulation indices:

2.404; 5.5201; 8.653; 11.791; 14.930; 18.071; 21.2116, etc.

The FM deviation indicated on the modulation meter is controlled by the setting of R29 (Fig. 8). A slight adjustment of this control may be made if desired; however the actual deviation sensitivity of the reactance modulator is adjusted by means of R47 (Fig. 14) within the RF shield, and should not be disturbed.

*REFERENCES—
Crosby, Murray G., "A Method of Measuring Frequency Deviation," RCA Review, Vol. 4, p. 473, April 1940.
Wachter, James E., "A Method of Measuring Frequency Deviation," BRC Notebook No. 9, Spring 1956.

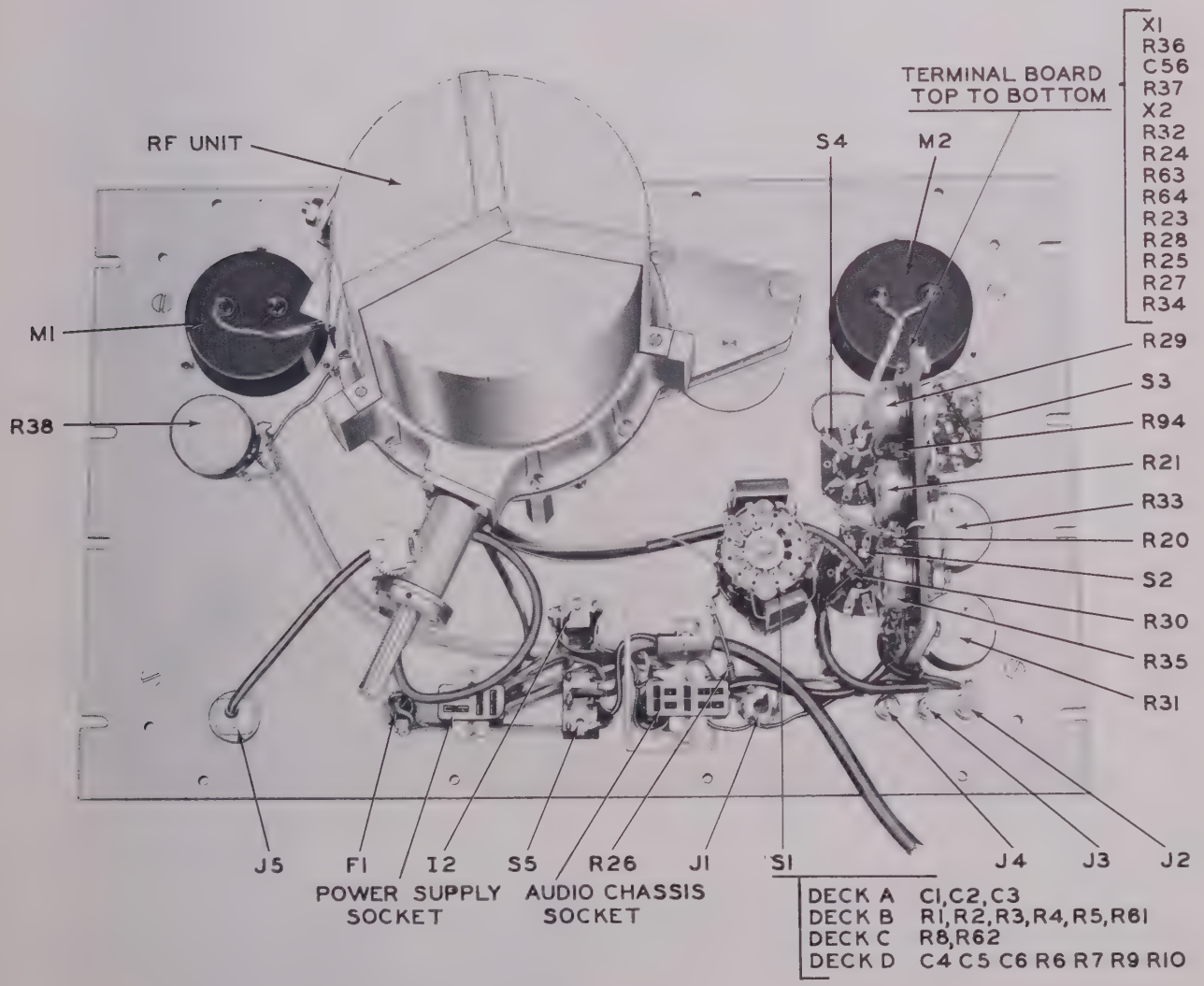


Fig. 8 Control Panel Assembly, Rear View

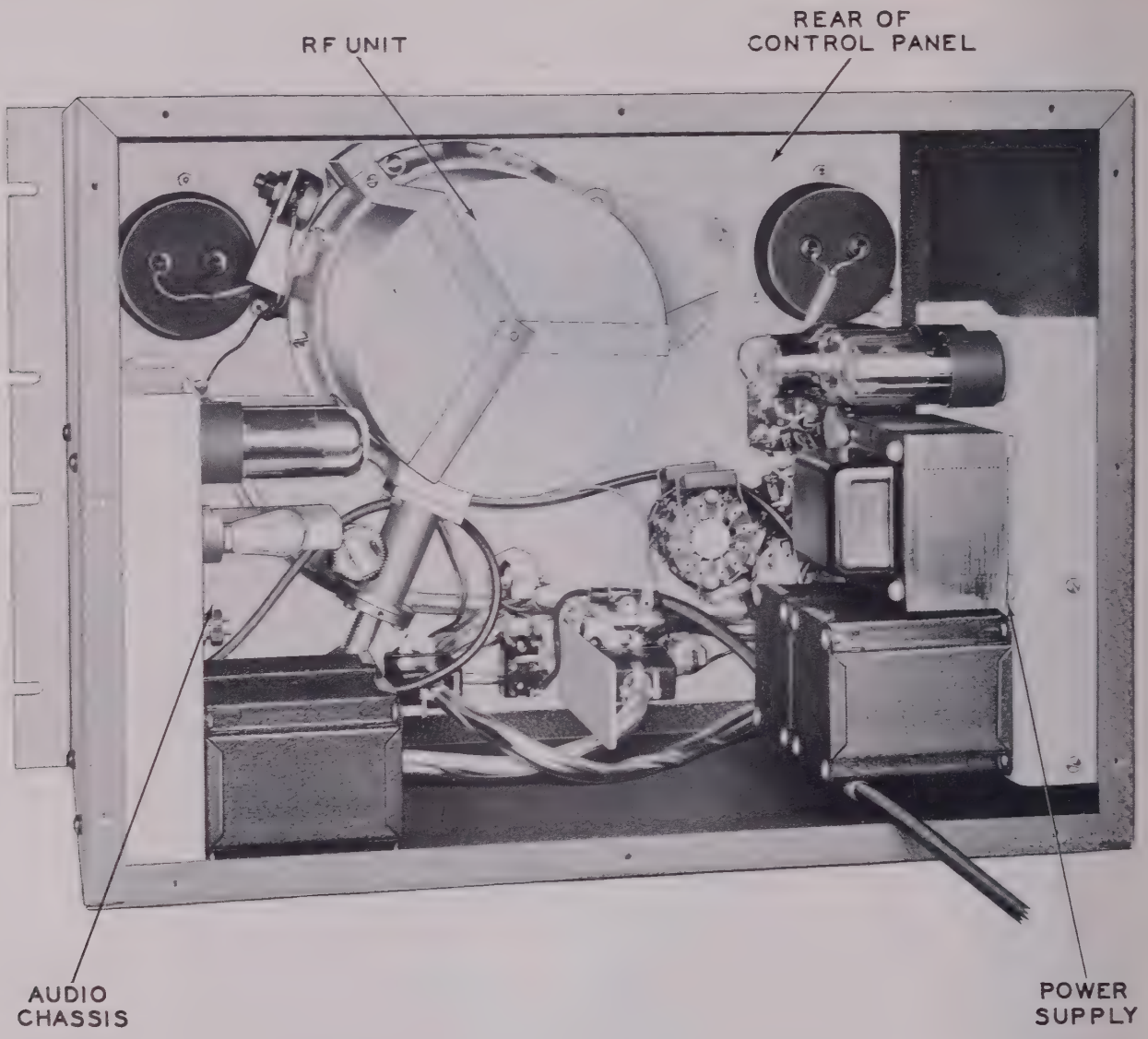


Fig. 9 RF Generator Chassis Assembly, Rear View

VR-150 REGULATOR TUBE (Fig. 12)

When replacing this tube (V4) it is desirable to check its current drain by placing a milliameter in series with the plate and adjusting R19 for a 7 milliampere plate current with the input voltage to the power transformer primary set at 105 volts, and the RF Monitor Meter pointer set to "red" line. The adjustment will insure proper operation of the power supply over a line voltage range of 105-125 volts.

VI. TROUBLE SHOOTING

Many cases of non-operation or malfunctioning are the result of tube failure. A visual inspection will often show a tube inoperative, and its replacement will restore normal performance.

If all the tubes light, but performance is abnormal, the tubes should be checked in a tube tester, and returned, if good, to the sockets from which they were removed.

To facilitate the detection and localization of possible trouble, two charts are presented in the following pages. The first, a "Trouble Chart", lists by symptoms some known trouble conditions and repair procedures. The second, a "Socket Voltage Chart", gives expected operating potentials for the stated conditions.

TROUBLE CHART

Symptom	*Probable Cause*	*Repair Procedure*
Modulation Meter and RF Monitor Meter do not read, Pilot Lamp inoperative	Fuse (3AG-2amp) open	Replace fuse
Modulation Meter and RF Monitor Meter do not read	V-3, C-13, C-14 faulty	Check, replace
RF Monitor Meter inoperative, VRF output nil*	R-18 open V-5, V-6, V-7, V-8 faulty	Replace R-18 See p. 15
RF Monitor Meter reading below red reference line	R-18 aged	Replace R-18
RF Monitor Meter inoperative, VRF output OK	M-1 faulty	Check, replace
Modulation Meter inoperative on FM and AM, no FM or AM on output signal, internal AF oscillator voltage nil at EXT OSC (FM and AM) binding posts	I-1, V-1, V-2 faulty	Check, replace. Adjust R-12 for 50-60 VAC at EXT OSC AM terminal posts
Modulation Meter inoperative on FM and AM [but FM and AM OK on output signal and internal AF oscillator voltage OK at EXT OSC (FM and AM) binding posts]	M-2 faulty	Check, replace
FM distortion and AM distortion high in RF output signal; internal AF oscillator voltage and distortion high at EXT OSC (FM and AM) binding posts	I-1 faulty	Replace I-1. Adjust R-12 for 50-60 VAC at EXT OSC AM terminal posts
Fuse blows repeatedly as soon as power is applied, or sometime after power is applied	V-3, C-13, C-14, or power transformer faulty	Check, replace

**NOTE: No RF output will be obtained with the audio oscillator unit plug P-1 detached from the front panel assembly because the DC screen supply for the final amplifier-doubler V-8 is wired from the power supply through the audio unit and thence to the RF panel.*

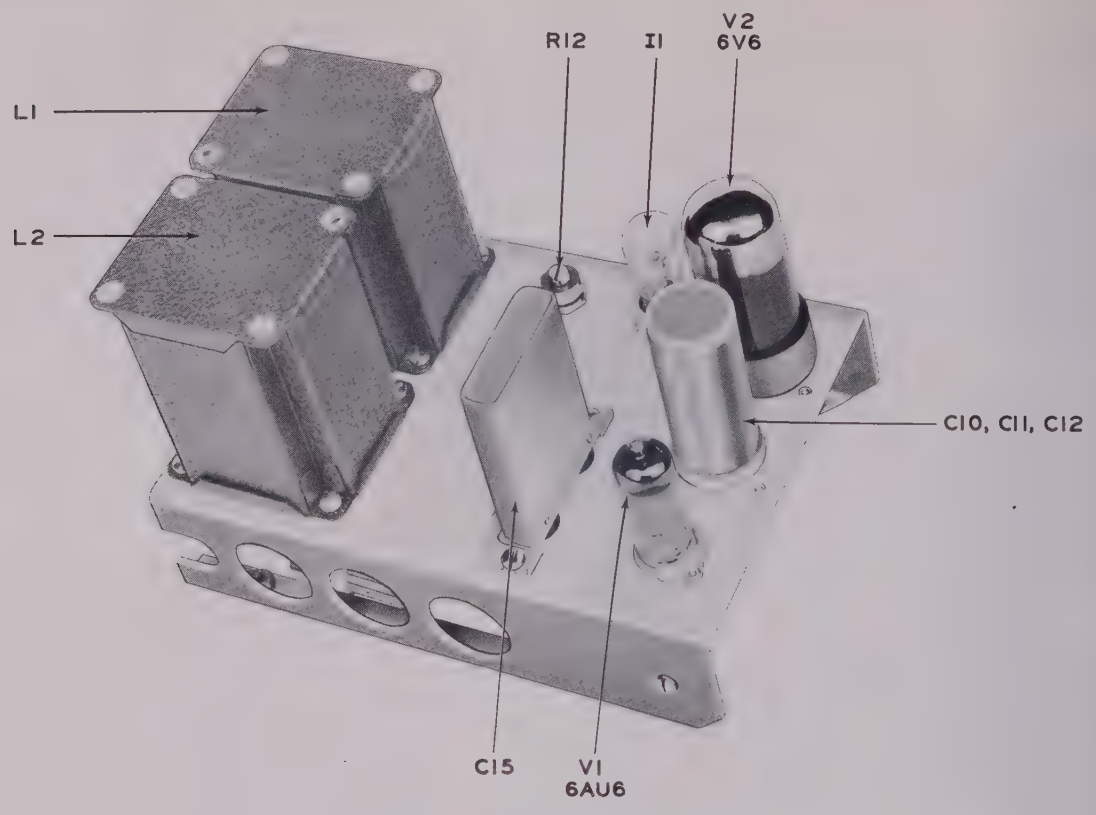


Fig. 10 Audio Oscillator Assembly, Top View

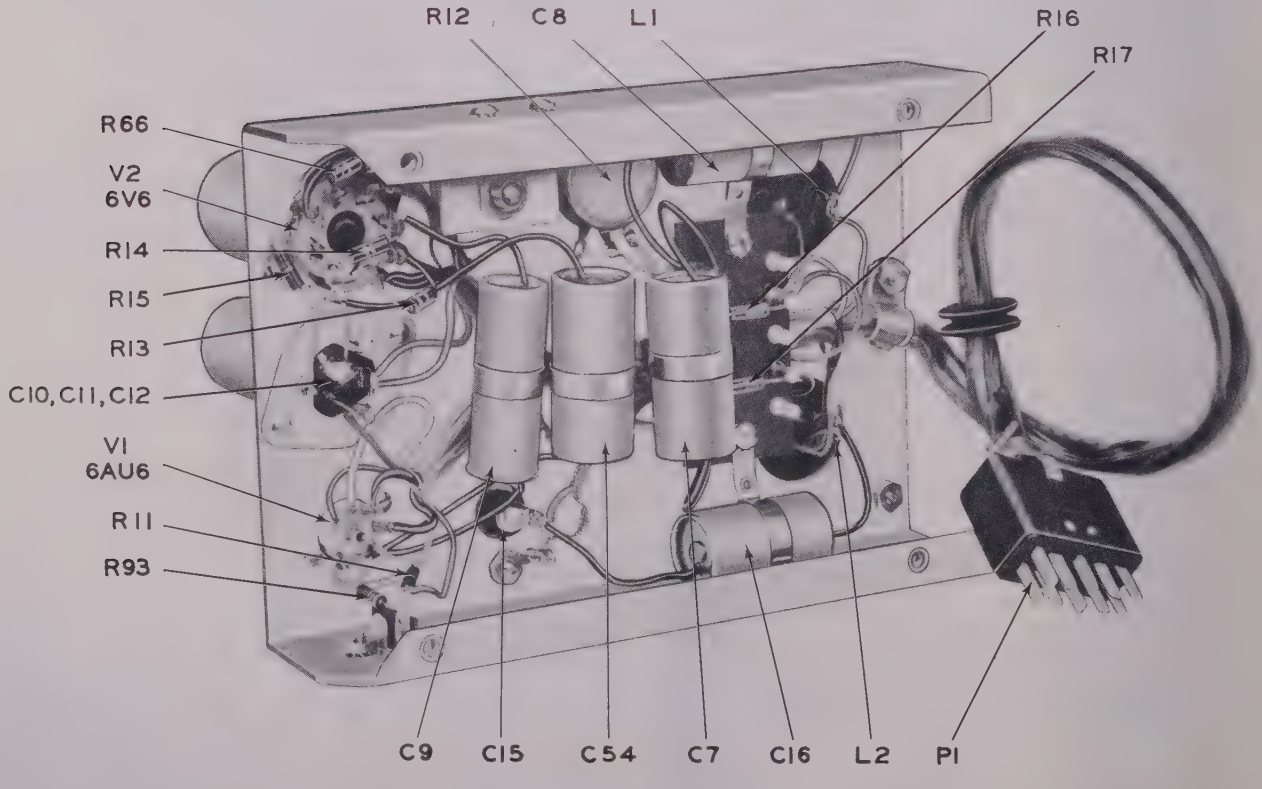


Fig. 11 Audio Oscillator Assembly, Bottom View

SOCKET VOLTAGE CHART

All voltages are DC unless otherwise indicated.
All DC measurements are made with 20,000 ohms per volt voltmeter.
All AC measurements are made with 1000 ohms per volt AC voltmeter.

Conditions for measurements:

a. Measurements made with respect to ground.
b. FREQUENCY MC DIAL set at 250 mc.
c. ATTENUATOR DIAL set at 100K Microvolt.
d. MODULATION SWITCH set at FM.
e. RF MONITOR METER set at red line.
f. MODULATION METER SWITCH at AM 100%.
g. MODULATION FREQUENCY SWITCH set at 400 cps.

	Pin Numbers							
Tubes	1	2	3	4	5	6	7	8
V-1 (6AU6)	0	2.7	3 A.C.	3 A.C.	150	85	2.7	
V-2 (6V6)	0	3 A.C.	210	135	3.5 A.C.	0	3 A.C.	4.5
V-3 (5Y3)	0	290	0	380 A.C.	0	380 A.C.	0	290
V-4 (VR-150)	0	0	0	0	150	0	0	0
V-5 (6AK5)	0	4.2	6.2 A.C.	0	140	140	4.2	
V-6 (6C4)	140	0	6.2 A.C.	0	140	—3.2	0	
V-7 (6AK5)	—0.25	0	6.2 A.C.	0	133	135	0	
V-8 (6AK5)	—1.3	0	6.2 A.C.	0	135	100	0	
R-18 (6H-6)	0	14 A.C.	0	0	0	0	6.6 A.C.	0

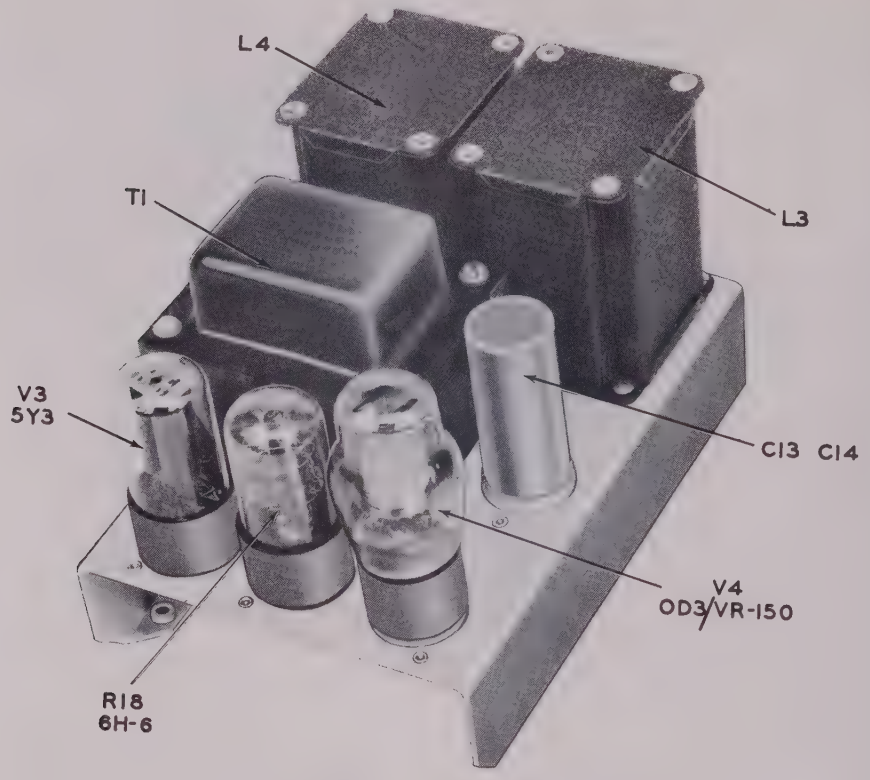


Fig. 12 Power Supply, Top View

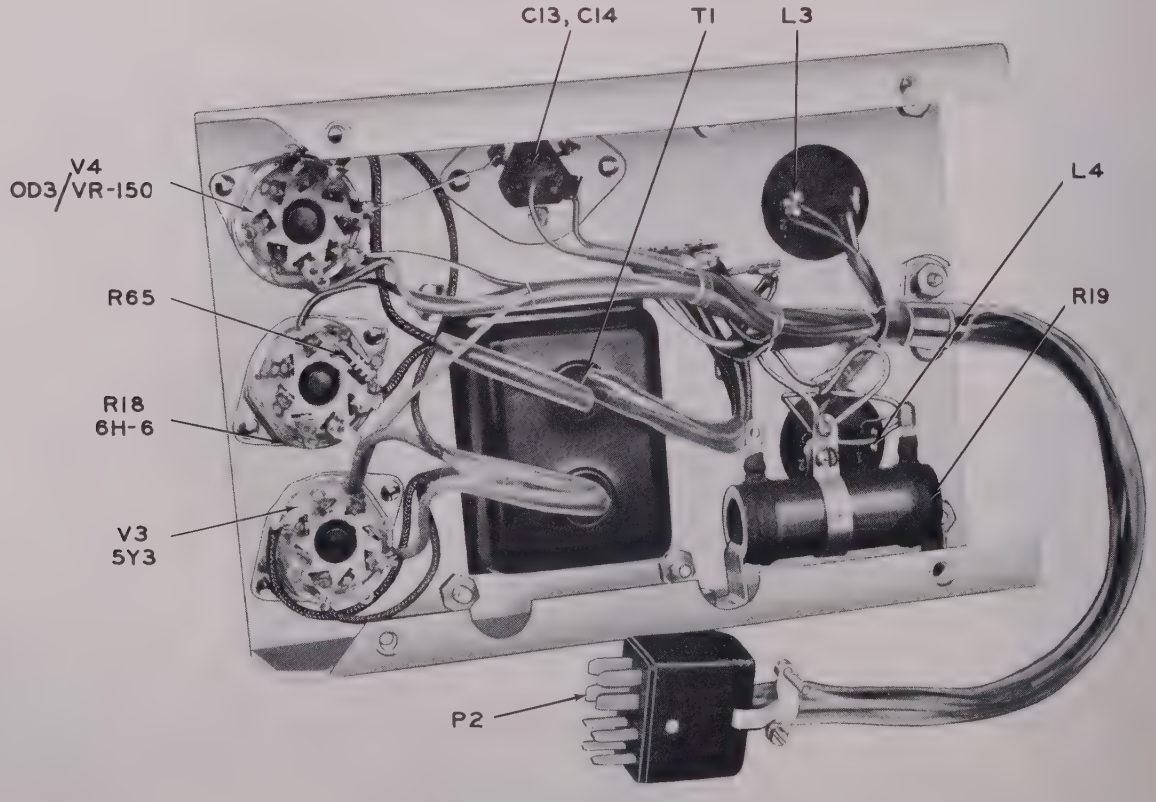


Fig. 13 Power Supply, Bottom View

VII. LIST OF REPLACEABLE PARTS

The following parts are replaceable. After replacement it is desirable to make the checks and adjustments described in Section V.

TYPE 202-F ELECTRICAL COMPONENT PARTS LIST

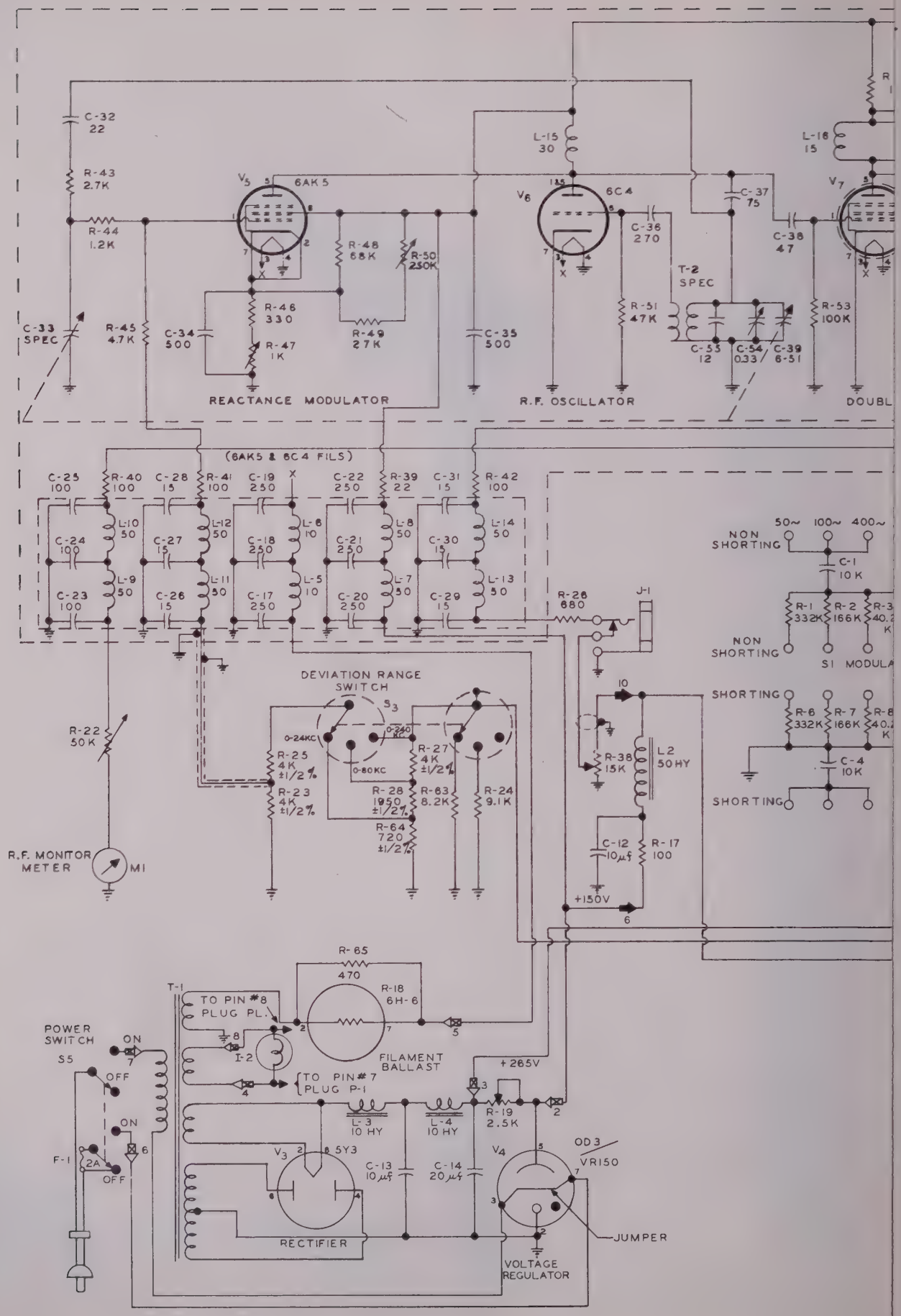
Circuit Symbol	Value	Description	BRC Part No.
C-1,4	10,000μμf	Capacitor, Fixed ±2% 300V Mica	82414
C-2,5	1,000μμf	Capacitor, Fixed ±2% 500V Mica	82302
C-3	500μμf	Capacitor, Fixed ±2% 500V Mica	82234
C-6	470μμf	Capacitor, Fixed ±2% 500V Mica	82239
C-7,54	40μf	Capacitor, Fixed 150V Electrolytic	83045
C-8,16	8μf	Capacitor, Fixed 450V Electrolytic	83028
C-9	0.1μf	Capacitor, Fixed 400V Electrolytic	83070
C-10,11,12,13,14	10-10-10μf	Capacitor, Fixed 400V Electrolytic	83050
C-15	1μf	Capacitor, Fixed 400V Electrolytic	83066
C-17,18,19,20,21,22	250μμf	Capacitor, Fixed ±10% 500V Sil Mica	82232
C-23,24,25	100μμf	Capacitor, Fixed ±10% 500V Sil Mica	82140
C-26,27,28,29,30,31	15μμf	Capacitor, Fixed ±10% 500V Sil Mica	82018
C-32	22μμf	Capacitor, Fixed ±5% 500V Ceramic	82030
C-33	Special	Capacitor, Variable Air Dielectric	
C-34,40	500μμf	Capacitor, Fixed ±10% 500V Sil Mica	82235
C-35	500μμf	Capacitor, Fixed ±10% 500V Sil Mica	82231
C-36	270μμf	Capacitor, Fixed ±5% 500V Mica	82137
C-37	75μμf	Capacitor, Fixed ±5% 500V Ceramic	82135
C-38,43,44	47μμf	Capacitor, Fixed ±5% 500V Ceramic	82132
C-39	Special	Capacitor, Variable Air Dielectric	
C-41	250μμf	Capacitor, Fixed ±10% 500V Sil Mica	82236
C-42	8μf	Capacitor, Fixed 450V Electrolytic	83029
C-45	Special	Capacitor, Variable Air Dielectric	
C-46	15μμf	Capacitor, Fixed ±10% 500V Sil Mica	82014
C-47	47μμf	Capacitor, Fixed ±5% 500V Ceramic	82109
C-48	1μμf	Capacitor, Fixed ±.25μμf 500V Ceramic	82138
C-49	250μμf	Capacitor, Fixed ±10% 500V Sil Mica	82230
C-50	Special	Capacitor, Variable Air Dielectric	
C-51,52,54	0.3-3μμf	Capacitor, Trimmer	84088
C-53	10μμf	Capacitor, Fixed ±10% 500V Ceramic	82016
C-55	12μμf	Capacitor, Fixed ±.5μμf 500V Ceramic	82012
C-56	0.01μf	Capacitor, Fixed 200V Paper	82402
F-1		Fuse 2A, 3AG2	93251
I-1		Lamp, Incandescent, 120V, 3W	90907
I-2		Lamp, Incandescent, 6.3V, 0.15A	90904
J-1		Jack, Midget	89039
J-2,4		Jack, Binding Post Insulated	304312
J-3		Jack, Binding Post Insulated	304311
J-5		Jack, BNC	89065
L-1,2	50 h	Choke, Filter	85433
L-3,4	10 h	Choke, Filter	85535
L-5,6	10μh	Coil, Radio Frequency	85575
L-7,8,9,10,11,12,13,14	50μh	Coil, Radio Frequency	85592
L-15	30μh	Coil, Radio Frequency	85598
L-16	15μh	Coil, Radio Frequency	85572
L-17	Special	Coil, Radio Frequency	85594
L-18	5.5μh	Coil, Radio Frequency	85584

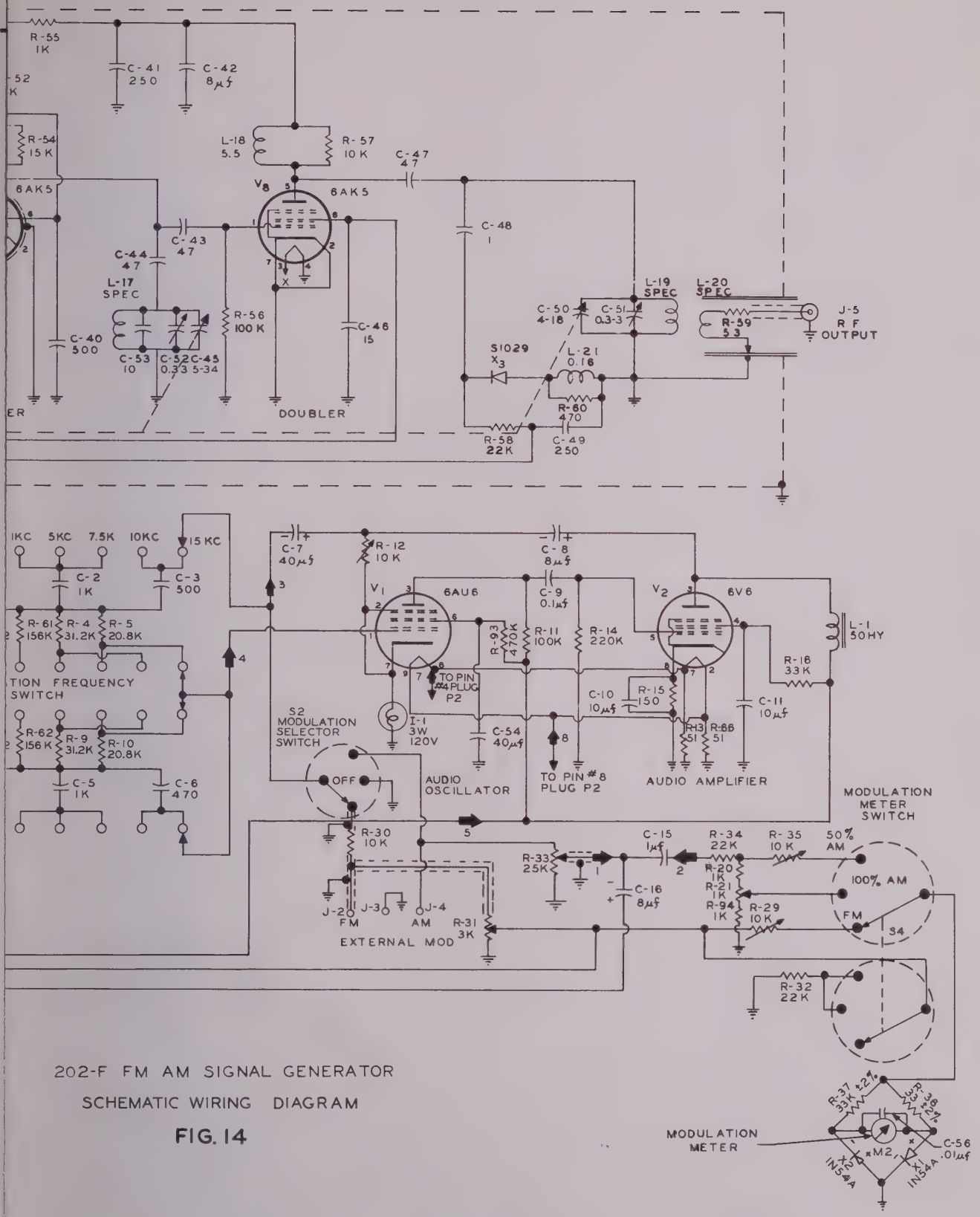
TYPE 202-F ELECTRICAL COMPONENT PARTS LIST — *Continued*

Circuit Symbol	Value	Description	BRC Part No.
L-19	Special	Coil, Radio Frequency	85595
L-20	Special	Coil, Radio Frequency	
L-21	0.16μh	Coil, Radio Frequency	85596
M-1		Meter, RF Monitor 100μA	92026
M-2		Meter, Modulation 100μA	92048
P-1		Plug, 10 Male Contacts	303335
P-2		Plug, 8 Male Contacts	94147
R-1,6	332KΩ	Resistor, Fixed $\pm$1% ½W Film	80630
R-2,7	166KΩ	Resistor, Fixed $\pm$1% ½W Film	80567
R-3,8	40.2KΩ	Resistor, Fixed $\pm$1% ½W Film	80492
R-4,9	31.2KΩ	Resistor, Fixed $\pm$1% ½W Film	80491
R-5,10	20.8KΩ	Resistor, Fixed $\pm$1% ½W Film	80490
R-11,52,56	100KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80517
R-12,29,35	10KΩ	Resistor, Variable $\pm$10% 2W Comp.	81314
R-13,66	51Ω	Resistor, Fixed $\pm$5% ½W Carbon	80088
R-14	220KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80555
R-15	150Ω	Resistor, Fixed $\pm$5% ½W Carbon	80098
R-16	33KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80461
R-17,40,41,42	100Ω	Resistor, Fixed $\pm$5% ½W Carbon	80062
R-18		Resistor, Thermal	91019
R-19	2.5KΩ	Resistor, Adjustable $\pm$5% 25W WW	80268
R-20,55,94	1KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80148
R-21,47	1KΩ	Resistor, Variable $\pm$10% 2W Comp.	81119
R-22	50KΩ	Resistor, Variable $\pm$10% 2W Comp.	81407
R-23,25,27	4KΩ	Resistor, Fixed $\pm$½% ½W Film	80247
R-24	9.1KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80327
R-26	680Ω	Resistor, Fixed $\pm$5% ½W Carbon	80138
R-28	1950Ω	Resistor, Fixed $\pm$½% ½W Film	80206
R-30,57	10KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80361
R-31	3KΩ	Resistor, Variable $\pm$5% 3W WW	81210
R-32,34,58	22KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80472
R-33	25KΩ	Resistor, Variable $\pm$10% 3W WW	81411
R-36,37	33KΩ	Resistor, Fixed $\pm$2% ½W Carbon	80486
R-38	15KΩ	Resistor, Variable $\pm$5% 3W WW	81331
R-39	22Ω	Resistor, Fixed $\pm$5% ½W Carbon	80713
R-43	2.7KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80225
R-44	1.2KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80201
R-45	4.7KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80304
R-46	330Ω	Resistor, Fixed $\pm$5% ½W Carbon	80172
R-47	1KΩ	Resistor, Variable $\pm$10% 2W Comp.	81005
R-48	68KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80552
R-49	27KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80487
R-50	250KΩ	Resistor, Variable $\pm$20% 2W Comp.	81608
R-51	47KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80460
R-54	15KΩ	Resistor, Fixed $\pm$5% ½W Carbon	85572
R-59	50Ω	Resistor, Fixed $\pm$1% ¼W Film	80048
R-60,65	470Ω	Resistor, Fixed $\pm$5% ½W Carbon	80170
R-61,62	156KΩ	Resistor, Fixed $\pm$1% ½W Film	80566
R-63	8.2KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80326
R-64	720Ω	Resistor, Fixed $\pm$½% ½W Film	80147
R-93	470KΩ	Resistor, Fixed $\pm$5% ½W Carbon	80640
S-1		Switch, Rotary, 4 Pole, 8 Position, 4 Section	88058

TYPE 202-F ELECTRICAL COMPONENT PARTS LIST — *Continued*

Circuit Symbol	Value	Description	BRC Part No.
S-2,3,4		Switch, Rotary, 2 Pole, 3 Position, 1 Section	88083
S-5		Switch, Toggle DPDT	88059
T-1		Transformer, Power, 117V, 50-60 cps	85074
T-2	Special	Transformer, Radio Frequency	85597
V-1		Tube	6AU6
V-2		Tube	6V6
V-3		Tube	5Y3
V-4		Tube	OD3/VR-150
V-5		Tube (Selected 6AK5)	543A
V-6		Tube (Selected 6C4)	544A
V-7		Tube (Selected 6AK5)	543A
V-8		Tube (Selected 6AK5)	543B
X-1,2	IN54A	Diode, Germanium	91091
X-3	S1029	Diode, Germanium	91093
		Holder, Fuse, Extractor Post	93677
		Lampholder, Candelabra Base	89026
		Light, Indicator, Miniature Bayonet	303876
		Socket, 8 Female Contacts	303079
		Socket, 10 Female Contacts	303283
		RF Unit, Complete	304417


C-32 22
R-43 2.7K
R-44 1.2K
V5 6AK5
R-48 68K
R-50 250K
R-46 330
R-47 1K
R-49 27K
C-33 SPEC
R-45 4.7K
C-34 500
C-35 500
REACTANCE MODULATOR
L-15 30
V6 6C4
C-36 270
R-51 47K
C-37 75
C-38 47
T-2 SPEC
C-53 12
C-54 033/
C-39 6-51
R-53 100K
L-16 15
V7
R-53 100K
R.F. OSCILLATOR
DOUBL
(6AK5 & 6C4 FILS)
C-25 100
R-40 100
C-28 15
R-41 100
C-19 250
C-22 250
R-39 22
C-31 15
R-42 100
C-24 100
C-27 15
C-18 250
C-21 250
C-30 15
C-23 100
C-26 15
C-17 250
C-20 250
C-29 15
L-10 50
L-12 50
L-8 10
L-8 50
L-14 50
L-9 50
L-11 50
L-5 10
L-7 50
L-13 50
R-28 680
J-1
50~ 100~ 400~
NON SHORTING
C-1 10 K
R-1 332K
R-2 166K
NON SHORTING
S1 MODULA
DEVIATION RANGE SWITCH
S3
0-24KC
0-240 KC
0-80KC
R-25 4K ±1/2%
R-27 4K ±1/2%
R-28 1950 ±1/2%
R-63 8.2K
R-24 9.1K
R-64 720 ±1/2%
R-22 50K
R.F. MONITOR METER
MI
10
R-38 15K
L2 50 HY
SHORTING
R-6 332K
R-7 166K
C-4 10K
SHORTING
C-12 10μf
R-17 100
+150V
6
R-65 470
T-1
TO PIN #8 PLUG PL.
R-18 6H-6
FILAMENT BALLAST
I-2
TO PIN #7 PLUG P-1
+265V
POWER SWITCH S5
ON
OFF
ON
F-1 2A
OFF
L-3 10 HY
L-4 10 HY
R-19 2.5K
V3 5Y3
C-13 10μf
C-14 20μf
V4 OD3 / VR150
JUMPER
RECTIFIER
VOLTAGE REGULATOR



202-F FM AM SIGNAL GENERATOR

SCHEMATIC WIRING DIAGRAM

FIG. 14

PLUG CONNECTIONS:

OSCILLATOR CHASSIS PLUG P1

POWER SUPPLY CHASSIS PLUG P2

POINT OF SYMBOL INDICATES DIRECTION OF WIRE COMING FROM PLUG PRONG INTO CABLE

NO. 1 PINS OF PLUGS P1 & P2 CONNECT TO GROUND

NOTE:

RESISTANCE IN OHMS
CAPACITANCE IN μμf
INDUCTANCE IN μHY
} UNLESS OTHERWISE SPECIFIED

K = 1,000

M = 1,000,000

APPENDIX

LIST OF ILLUSTRATIONS

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2	Output Circuit of 202-F or 207-F with 501-B Output Cable Attached	27
3	Equivalent Output Circuit of 202-F or 207-F with 501-B Output Cable Attached	27
4	505-B T-Pad as Dummy Antenna for Receiver	27
5	Equivalent Circuit of a 505-B T-Pad as an Antenna	28

APPENDIX

OUTPUT CONNECTIONS

A. The method of connecting the load to the 202-F Signal Generator or to the 207-F Univerter must be considered to insure proper interpretation of results, and the following discussion is offered as an aid to the user.

It is convenient to represent a signal source in terms of its open circuit voltage and internal impedance.* Thus a signal source or an antenna can be represented as in Figure 1. For simplicity, only the case where source and load impedance are resistive will be considered.

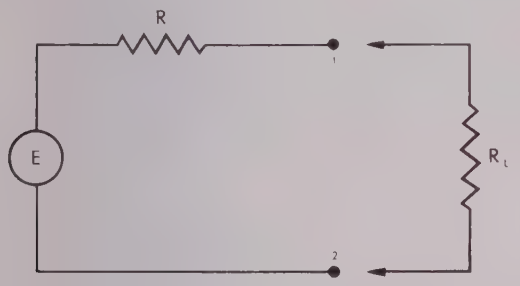

Fig. 1 Signal Source Representation

E — open circuit voltage
R — impedance looking into terminals 1 and 2
R_L — load impedance

For purposes of rating sensitivity, the input to a receiver might have been defined initially either as the open circuit source voltage E or the voltage actually across the receiver's terminals. The Institute of Radio Engineers has established the former method as standard and defined receiver input in terms of the open circuit voltage of the source.**

The impedance of the signal source employed to test receivers should be equal to the impedance of the antenna with which the receiver is designed to operate. Note that in this case the voltage actually across the receiver terminal is $\frac{E}{2}$ (Receiver input impedance equal to source impedance.)

**General Radio Experimenter, Vol. XXI, No. 1, June, 1946.*

***The Institute of Radio Engineers, Section 4.01.01, 1947, Standards on Radio Receivers, The Institute of Radio Engineers, Section 4.01.01, 1948, Standards on Television.*

B. *Accessories* for physically connecting the instrument to the load are described in the following:

1. *501-B Output Cable (supplied with 202-F)*

A 501-B Cable attached to the 202 or 207 is illustrated by Figure 2, where R_2 is the 50 ohm termination of the 501-B cable. The equivalent circuit (Figure 3) is readily determined by applying Thevinin's theorem. This arrangement is recommended for general use where it is desirable to connect the 202 or 207 output to an input circuit of relatively higher impedance than 25 ohms. The attenuator of the 202 will read the output directly.

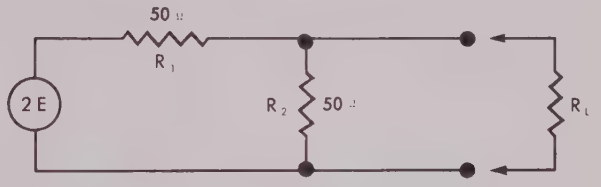

Fig. 2 Output Circuit of 202-F or 207-F with 501-B Output Cable Attached.

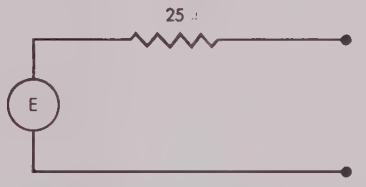

Fig. 3 Equivalent Output Circuit of 202-F or 207-F with 501-B Output Cable Attached

E — 202 attenuator dial reading
R_1 — internal resistance of 202 or 207
R_2 — 501-B cable termination
R_L — load impedance

2. *505-B, 6db Pad*

This pad is used as a dummy antenna in testing unbalanced receivers with a 50-ohm input as shown in Figure 4.

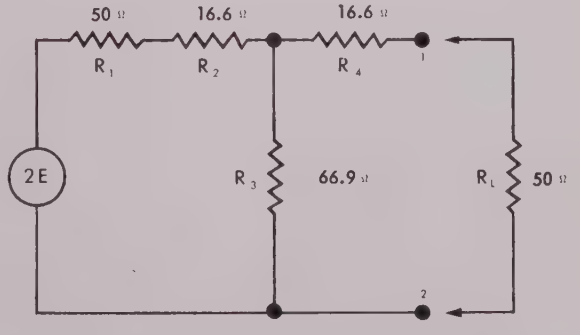

Fig. 4 505-B T-Pad as Dummy Antenna for Receiver

E — 202 attenuator dial reading
R_1 — internal resistance of 202 or 207
R_2 — pad resistance

R_3 — pad resistance
R_4 — pad resistance
R_L — load impedance

The open circuit voltage appearing across terminals 1 and 2 is by Ohms law (equation 1) equal to E, half of the source voltage. Applying Thevinin's theorem

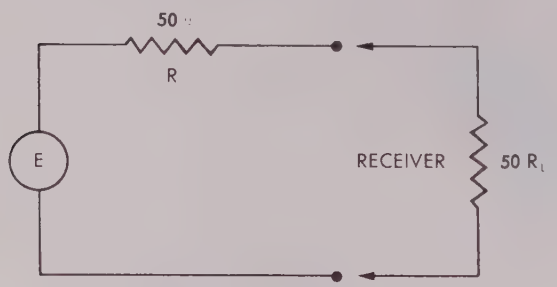

Fig. 5 Equivalent Circuit of a 505-B T-Pad as an Antenna

the equivalent circuit of Figure 5 is obtained, and thus the attenuator dial of the 202 reads receiver sensitivity directly for the assumed standard output.

3. *509-B 20 db T-Pad (Supplied with the 207-F)*

This pad is useful where signal levels are required which are low compared to the constant noise level of the 207. Since the noise level of the 207 is constant, the signal to noise ratio varies directly as the signal level. Therefore, with low output voltage the signal to noise ratio may be improved by increasing the input voltage and attenuating the output. For practical purposes the 20 db pad is useful at output levels below 5,000 microvolts for the 202-F. The signal applied to a 50-ohm load may be found by dividing the 202 attenuator dial reading by ten.

The 509-B pad, like the 505-B, may be used as a dummy antenna except that the measure of receiver sensitivity (equivalent source voltage) is one-fifth the 202 attenuator dial reading.

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY

INSTRUCTION BOOK ADDENDUM
TYPE 207-G UNIVERTER
(Supersedes 207-F)

Description

The Type 207-F Univerter has been modified and assigned a new type number, Type 207-G. The 207-G has an internal heterodyne oscillator operating at a semi-fixed frequency of 195 mc which is beat with the output signal of the 202-G FM - AM Signal Generator to provide output frequencies of from 100 kc to 55 mc.

Specifications

The 207-G specifications, when used with the 202-G, are identical to those given on pages 5 and 6 of the 207-F instruction book.

Parts Changes

The Electrical Components Parts List on pages 12 through 14 of the 207-F instruction book will serve as a parts list for the 207-G with the following changes:

Circuit Symbol	Value	Description	BRC Part No.
C-121		Deleted	
C-134	7.7uuf	Capacitor, Fixed: ±2%, NPO, 500V	82042
L-109, L-110		Oscillator and Pickup Coil Assembly	306695

FPM:9/1/60

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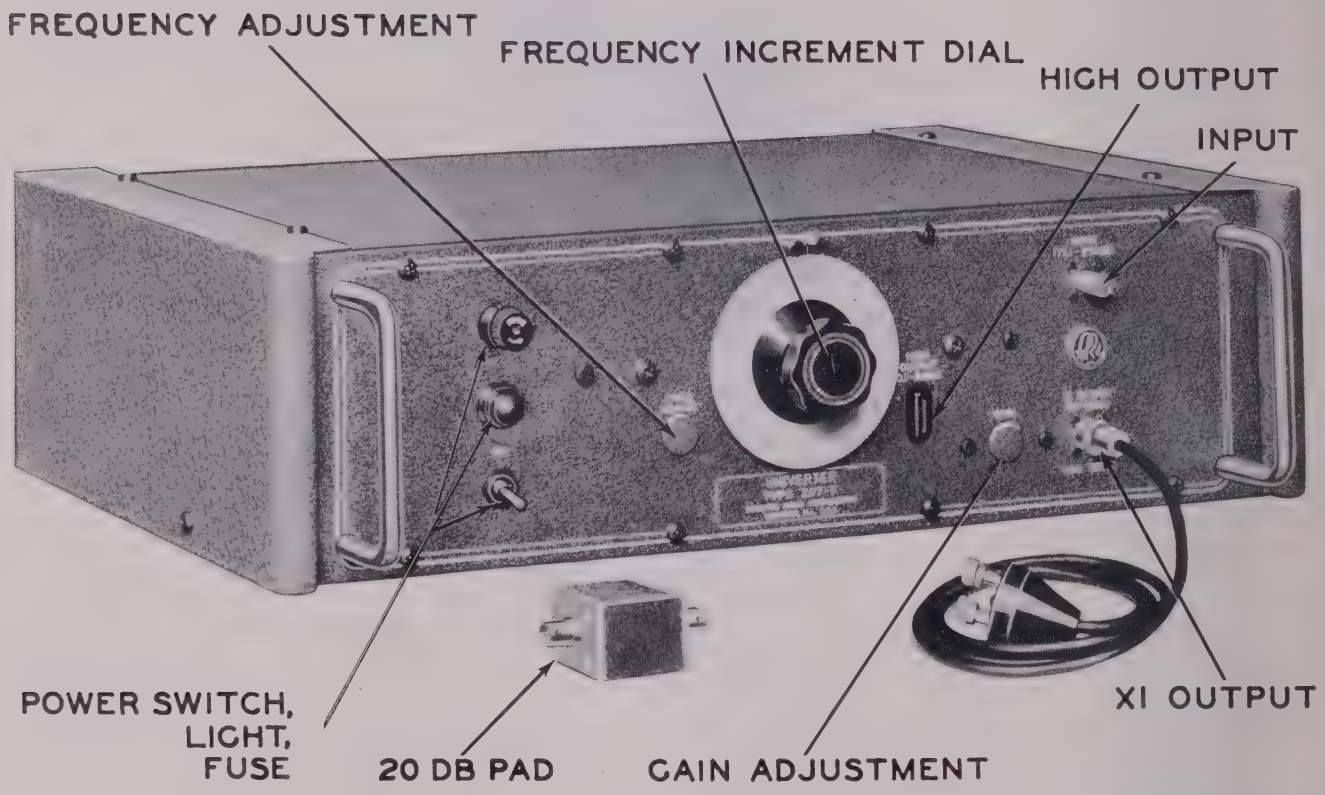


Fig. 1 Front Panel Control and Layout

I. INTRODUCTION

GENERAL

The Type 207-F Univerter, a frequency converting accessory of unity gain, is designed for use with the Type 202-F FM-AM Signal Generator to provide additional frequency coverage of 0.1 mc. to 55 mc. Since the 202-F FM-AM Signal Generator covers a frequency range from 175 to 250 megacycles, the 207-F offers a simple and convenient means whereby the additional coverage of commonly used intermediate and radio frequencies may be obtained. This instrument also makes available at these lower frequencies the frequency and amplitude modulation features and the attenuator calibration of the 202 instrument, without adding any appreciable distortion.

Physically, the Univerter consists of a front panel assembly, RF chassis, and regulated power supply. The power supply chassis is secured to the equipment cabinet, while connections to the RF chassis are made with a cable and plug arrangement from the front panel. The entire assembly is both lightweight and compact, matching the type 202-F FM-AM Signal Generator in proportions and finish.

The cabinet is so designed that the unit may be used as bench type equipment or quickly converted for mounting in a standard 19 inch rack.

All operating controls are located according to function on the front panel.

For convenience in carrying and protection of the front panel controls, two utility handles have been provided on the front panel.

This instrument is supplied complete with tubes, instruction manual, six plugs for the HIGH OUTPUT jack, 20 db T-Pad Type 509-B, and patch cord Type 502-B.

PRELIMINARY INSTRUCTIONS

Set up the 207-F Univerter for use as follows: Connect the 501-B output cable (or suitable cable-adapter combination) to the X1 OUTPUT of the Univerter, connect the 207-F input jack to the 202-F output jack using the Type 502-B patch cord, energize both instruments from any convenient 105-125 volt, 60 cycle power line and allow one hour warm up period before proceeding. (The 207 alone may operate from a 90-130 V, 60 cycle power line.)

To prepare this instrument for rack mounting it is only necessary to, (1) remove the externally available screws securing the two end-bells to the cabinet, (2) remove the end-bells exposing the rack mounting holes in the front panel, and (3) remove the four rubber feet from the bottom of the cabinet.

II. SPECIFICATIONS

RF Range

When used in combination with the 202-F, the RF range is as follows:

Service	*Lower Freq. Limit*	*Upper Freq. Limit*
CW	100 kc	55 mc
AM-Modulation —	100 kc + Modulation Frequency	55 mc
FM-Modulation —	100 kc + Deviation Frequency + Modulation Frequency*	55 mc

**Radio Engineering, F. E. Terman, Third Edition, Page 486.*

Gain

The gain when used in combination with the 202-F, is constant at unity to within ± 1 db.

Frequency Increment Dial

This dial is calibrated in 5-kc divisions over a range of ±300 kc.

RF Output

1. X1 Output.

The RF output voltage across a 50 ohm load connected to the X1 OUTPUT jack is continuously variable from 0.1 microvolt to 0.1 volt by means of the 202-F FM Signal Generator attenuator. At 0.2 volt input, the output is approximately 0.18 volt.

2. High Output

The RF output voltage at the HIGH OUTPUT jack is uncalibrated but may be controlled from the attenuator of the 202 FM-AM Signal Generator to give a maximum of about 1.5 volts.

Output Impedance

1. 1 Output.

The impedance at the X1 OUTPUT jack, looking into the instrument terminal is approximately 50 ohms.

2. High Output

At this jack the internal impedance is approximately 330 ohms.

Distortion

1. FM. The Univerter introduces no appreciable distortion when a frequency modulated voltage is applied from the 202-F Signal Generator.

2. AM. At carrier levels below 0.05 volts the Univerter adds no distortion to a 50% AM modulated signal. Above this level some rounding of the outward modulation peaks may occur.

Leakage

The RF unit is completely shielded, being enclosed within an aluminum casting having silver plated brass cover plates screwed firmly in place. The oscillator section is well shielded from the remainder of the RF unit by aluminum walls within the main casting. This

use of shielding reduces leakage to a low value. Leakage of the fundamental frequency is a maximum at 55 mc and occurs at the HIGH OUTPUT plug. This leakage is 50 db below the desired signal.

Spurious RF Output

All spurious RF output voltages at input levels of less than 0.05 volts are at least 30 db below the desired signal.

Noise

FM hum modulation is more than 55 db below 10 kc deviation.

Random noise is 4 μv over a 20 kc band width.

Frequency Stability

0.005%/hr. after 1 hour warmup.

Power Supply

The 207-F Univerter is designed for use on 60 cycles, 95-130 volts, with a power consumption of 45 watts. The 207-FP is designed for use on 50~, 95-130V.

Tube Complement

Oscillator - 6C4 (V-105)
Mixer - 6AB4 (V-101)
RF Amplifier - 6AK5 (V-102, V-103)
Output Stage - 6AH6 (V-104)

Dimensions

L — 19¼" W — 5 5/16" Depth — 10⅞"

Weight 21 lbs.

III. OPERATING CONTROLS

Front Panel

1. Power Switch.

This switch applies power to the circuits when in the "ON" position.

2. Fuse

One fuse in the primary of the voltage stabilizer protects the instrument. This fuse is replaceable from the front panel.

3. Pilot Lamp

A red lamp, which when lit indicates the circuits are energized. The bulb is replaceable from the front panel.

4. Freqency Increment Dial

This control, calibrated in 5 kc increments, permits the output frequency to be varied a total of ± 300 kc.

5. Input Jack

Provides the means of coupling the output of the 202-F Signal Generator to the 207-F Univerter.

6. X1 Output Jack

Provides the means of obtaining the Calibrated output of the Univerter.

7. High Output Jack

Provides the means of obtaining the uncalibrated, high-level output of the Univerter.

8. Frequency Adjust Control

This control is used in the setting of the frequency of the internal oscillator and is accessible by removing the plug button from the Univerter front panel.

9. Gain Adjustment

This control is used in the setting of the Univerter gain and is accessible by removing the plug button from the front panel.

IV. THEORY OF OPERATION

(See Figs. 2 and 8)

LOCAL OSCILLATOR

A 6C4 triode V105 functions as a modified Colpitts oscillator operating at a frequency of 175 mc. Vernier

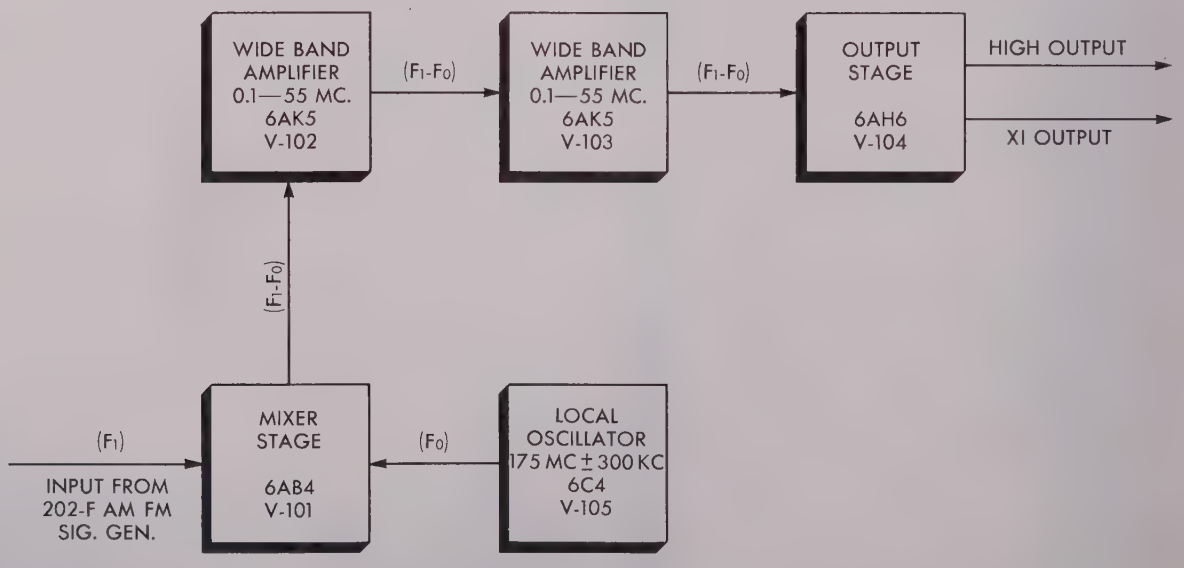


Fig. 2 Basic Elements of 207-F Univerter

capacitor C135 permits the 175 mc center frequency to be shifted up or down the frequency spectrum a maximum of 300 kc. The "Frequency Increment Dial" on the front panel of the instrument controls this vernier capacitor and is calibrated in 5 kc. increments, permitting relatively small changes in output frequency to be made such as are required for receiver selectivity measurements. Variable capacitor C137 available through access hole marked "FREQ", provides a means of zero beating the oscillator with the 175 mc output of the 202 generator with which the 207 is associated. A high degree of oscillator stability is obtained through the use of temperature compensating capacitors.

MIXER

The 6AB4 triode V101 as used is an excellent mixer, because of its very high g_m and because its physical characteristics suit it ideally to high frequency use. The pick up coil L110 introduces the 175 mc local oscillator signal to the grid of the 6AB4 triode V101 while the signal from the associated 202 develops a voltage across the cathode resistor R-101. V-101 mixes the two signals to produce a difference frequency. The 68-ohm cathode resistor shunted by the tube internal impedance of V101 provides the proper 50 ohm termination for the input cable and a 50 ohm termination for the associated 202 generator whose attenuator dial will therefore read directly the voltage applied to the Univerter.

WIDE BAND AMPLIFIER

The two wide-band cascaded amplifier stages V102 and V103 employ four-terminal, low pass, dead-end filter coupling networks, which pass 0.1 to 55 mc. Gain of the instrument is set to unity by means of potentiometers R128 and R117 in the cathode circuits of the 6AK5 tubes V102 and V103 respectively. Cathode degeneration minimizes Miller effect so that the pass band characteristics are independent of gain control settings. The trimmer condensers in the filter networks are used to adjust for a uniform gain over the entire pass-band.

OUTPUT STAGE

The 6AH6 output stage V104 is both cathode and plate loaded. The plate loading has virtually no effect upon the cathode output circuit, indicating that the 6AH6 operates as very nearly a perfect pentode.

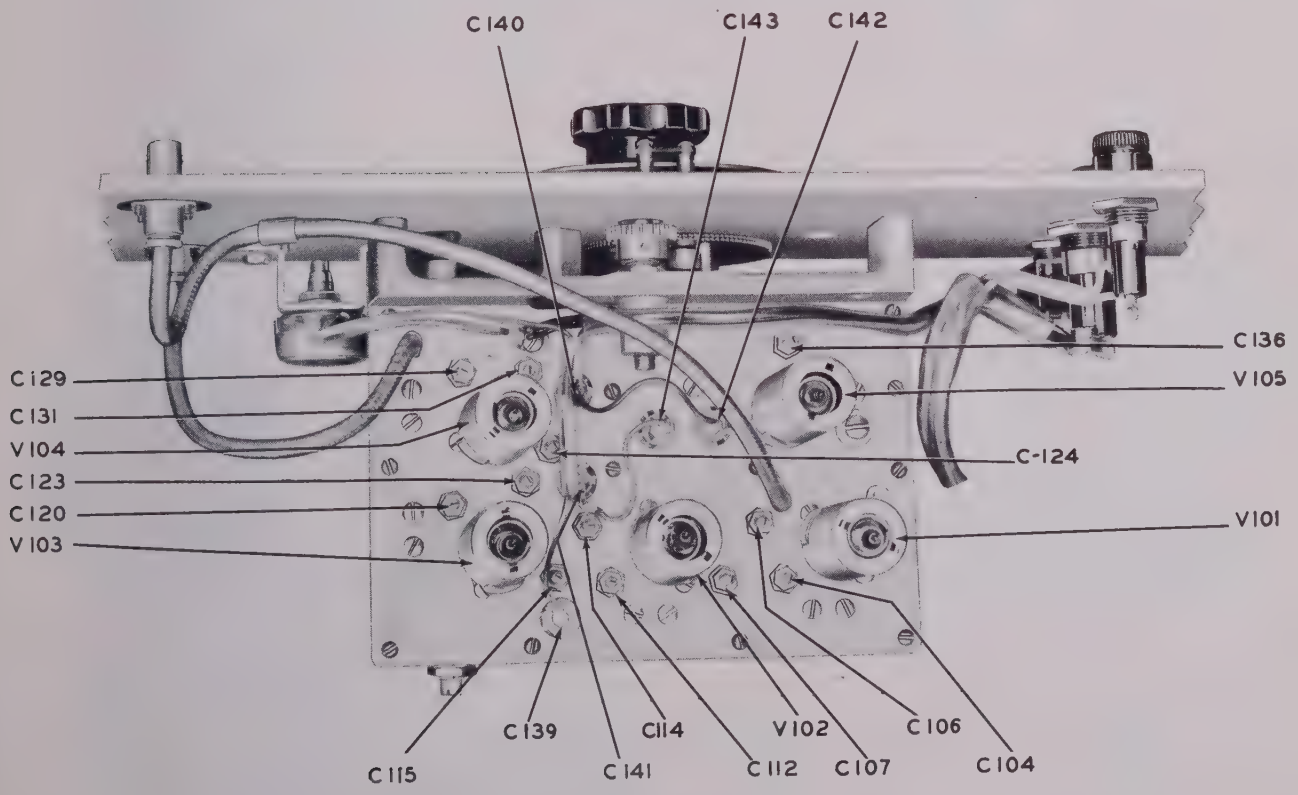


Fig. 3 Top View of Chassis

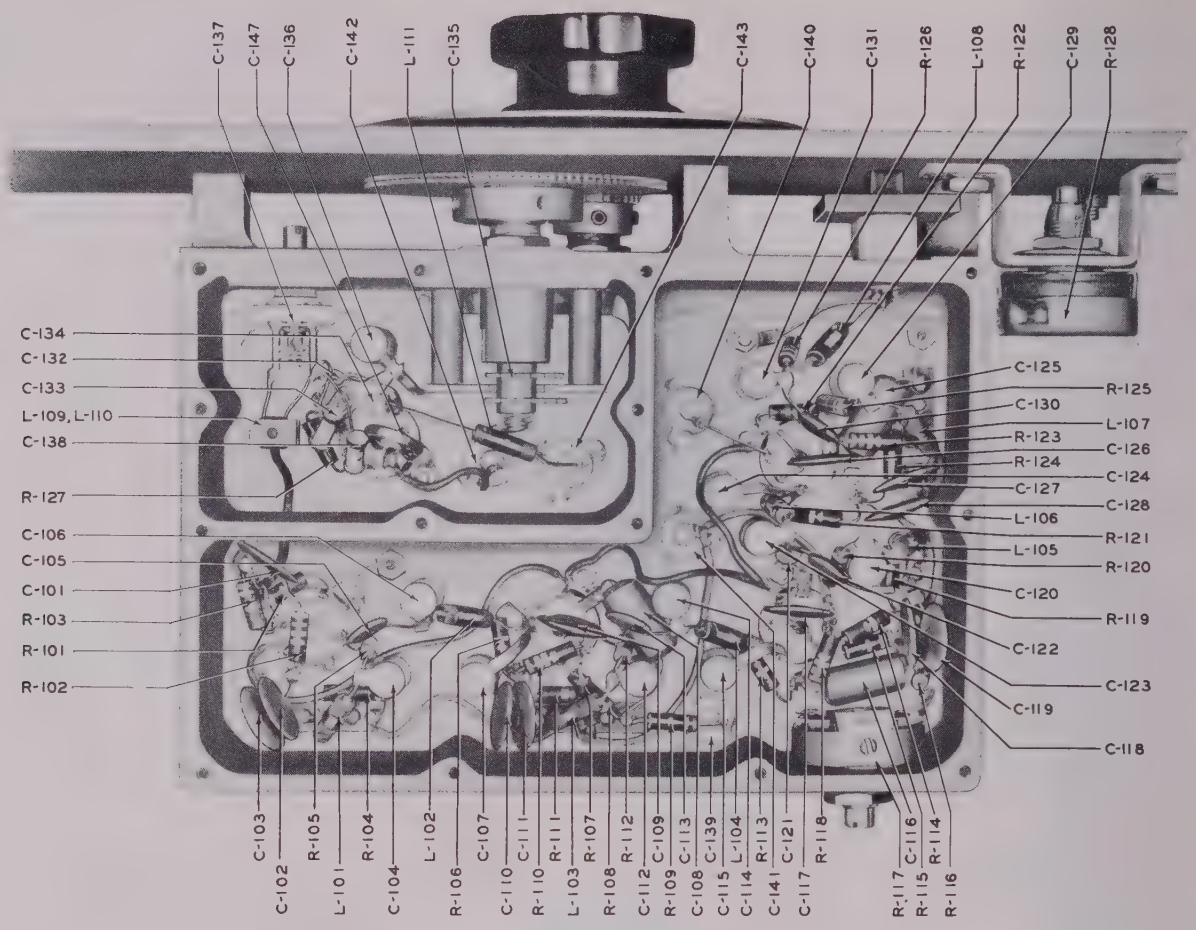


Fig. 4 Bottom View of Chassis

The value of resistance chosen for the cathode resistor is such that the output impedance is 50 ohms. The gain of the Univerter is set so that the open circuit voltage across the 50 ohm internal impedance is twice the input voltage. It follows then that the voltage across an external load is obtained by use of ohms law:

$$1.\ E_o = 2E \frac{Z_L}{Z_I + Z_L}$$

Where E_o = 207 output voltage
E = 202 attenuator dial reading
Z_L = load impedance
Z_I = internal impedance

When the external load is 50 ohms the effective gain of the instrument is unity and the attenuator dial of an associated 202 reads the Univerter output directly.

The plate output offers an open circuit gain of 7.5 to 8 times the input voltage at an internal impedance of approximately 330 ohms. This circuit is factory adjusted for maximum pass band flatness with 10 $\mu\mu$f connected externally to simulate an average external load, which is approximately equivalent to a short length of 300 ohm twin lead plus the input capacitance of a vacuum tube. Although the bandpass as viewed across the cathode is independent of plate load the reverse is not true due to changed degeneration resulting from change in cathode load. Therefore a 501-B cable or equivalent 50 ohm termination must be connected as a cathode load if optimum flatness is desired at the high impedance plate output.

V. MAINTENANCE INSTRUCTIONS

FREQUENCY ADJUSTMENT

The frequency of the Univerter oscillator is checked by zero-beating with a 202 generator. This inspection should be made upon receipt of initial delivery and occasionally thereafter. To perform the check connect a null indicator such as a pair of earphones or a sensitive vacuum tube voltmeter to the high output of the Univerter and set the 202 frequency dial to 175 mc. Remove the plug button marked "FREQ" from the 207 front panel, and adjust variable capacitor C137 for

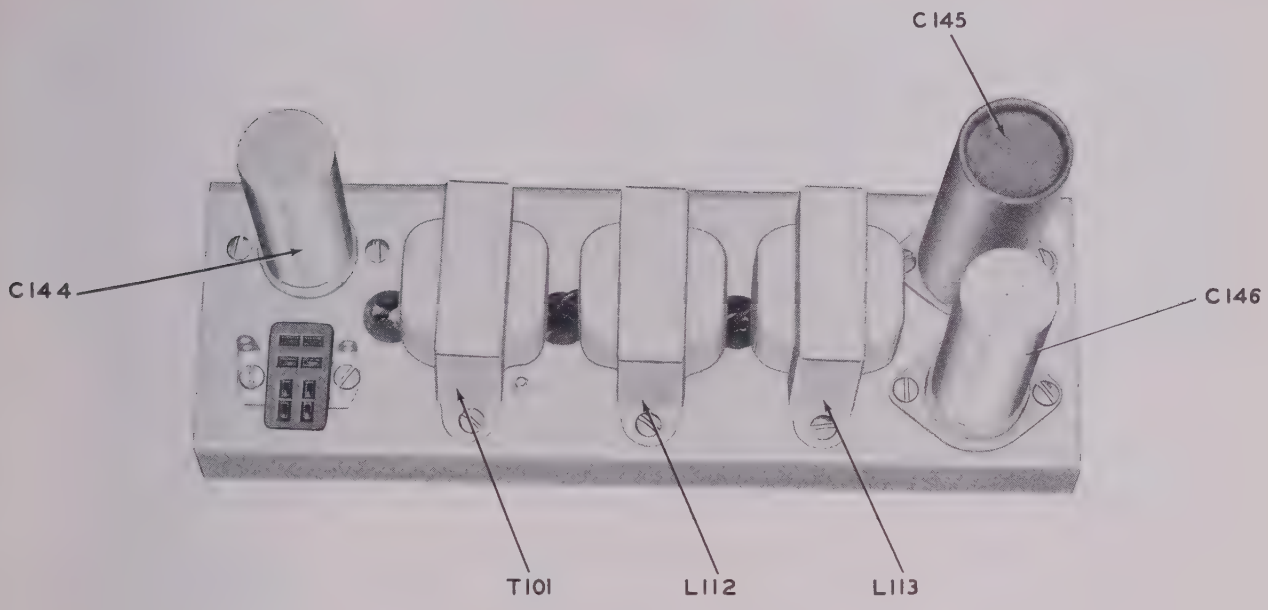


Fig. 5 Power Supply Chassis — Top View

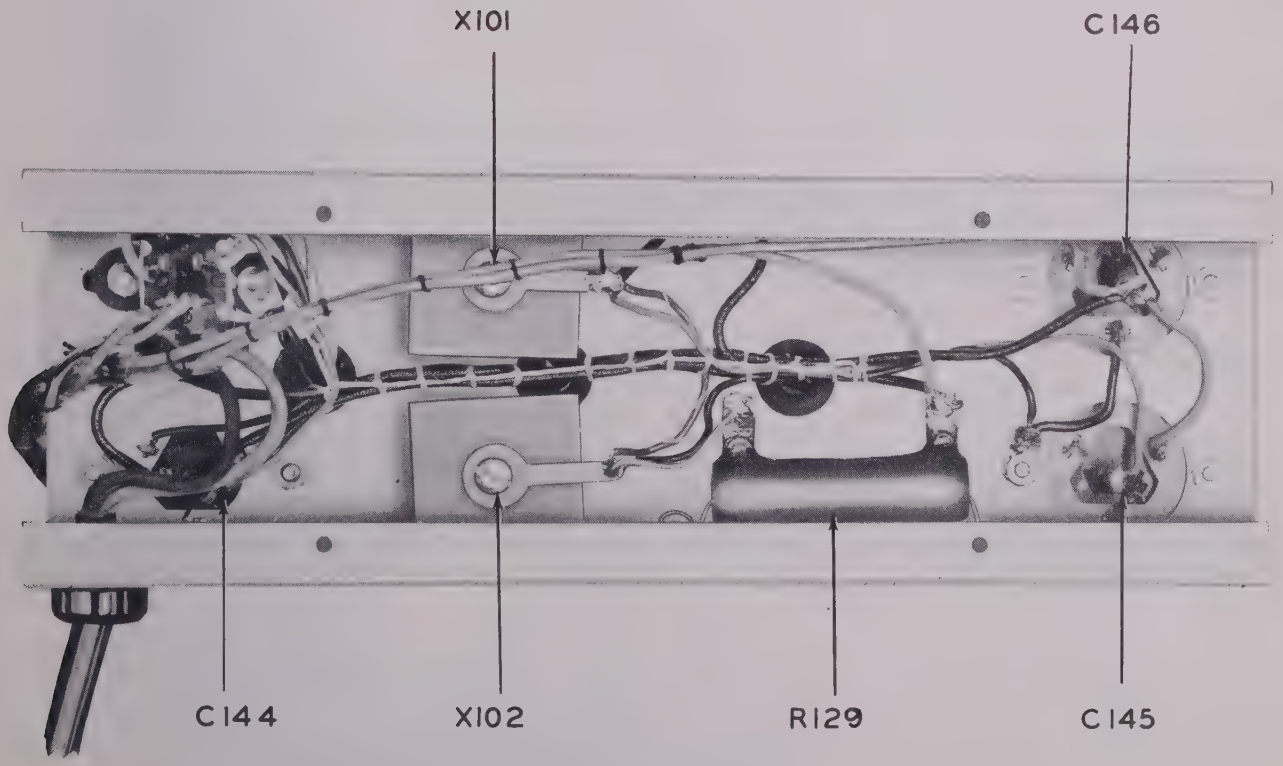


Fig. 6 Power Supply Chassis — Bottom View

zero beat.

GAIN ADJUSTMENT

The gain of the Univerter may be measured by comparing its output voltage as read on a vacuum tube voltmeter with the input voltage from the 202, indicated by the attenuator dial. Connect an accurate vacuum tube voltmeter to the X1 OUTPUT with a 501-B cable and shift the 207 oscillator frequency about 100 KC from zero-beat by means of the "Frequency Increment Dial." The reading of the vacuum tube voltmeter and the attenuator may be made equal (unity gain) by adjusting the first amplifier cathode potentiometer R128 (Fig. 4), accessible by removing the plug button marked "GAIN" from the front panel.

VI. TROUBLE-SHOOTING

Many cases of non-operation or malfunctioning are the result of tube failure. A visual inspection will often show a tube inoperative, and its replacement will restore normal performance.

If all tubes light, but performance is abnormal, the tubes should be checked in a tube tester, and returned, if good, to the sockets from which they were removed.

To facilitate the detection and localization of possible trouble, two charts are presented in the following pages. The first, a "Trouble Chart", lists by symptoms some known trouble conditions and their remedies. The second, a "Socket Voltage Chart", gives average operating potentials under stated conditions.

TROUBLE CHART

Symptom	*Probable Cause*	*Repair Procedure*
Univerter inoperative, Pilot light and tubes do not light	Defective fuse F101.	Replace fuse. If new fuse burns out, check power supply for short circuit
No output from Univerter	No voltage from power supply	Check power supply components and replace any found to be defective
	Defective tube	Check tubes in tube tester and replace any found to be defective
Low output signal at both output jacks	Defective tube	Check tubes in tube tester and replace any found to be defective
	Gain not set to unity	Adjust gain to unity with R128. If R128 has insufficient control, reset R117 and then readjust R128
Output frequency incorrect	FREQ ADJUST capacitor C137 incorrectly set	Adjust capacitor C137 for correct frequency
	Defective oscillator tube V105	Replace oscillator tube and recheck calibration
	Power supply voltage too low or too high	Measure power supply filament and DC voltages. Check filter capacitors for leakage and rectifiers for excessive resistance. Test voltage stabilizing transformer T-102 for regulation. Replace defective components
Excessive lock-in of oscillator and signal generator frequencies	Defective mixer tube V101 or oscillator tube V105	Check tubes in tube tester and replace if found to be defective
Excessive hum on carrier	Poor filtering of power supply voltage	Check power supply filter capacitors and replace if found to be defective
	Bottom plate not firmly secured to Univerter chassis	Tighten bottom plate holding screws
	Defective plate or screen bypass capacitor	Check capacitors and replace any found to be defective

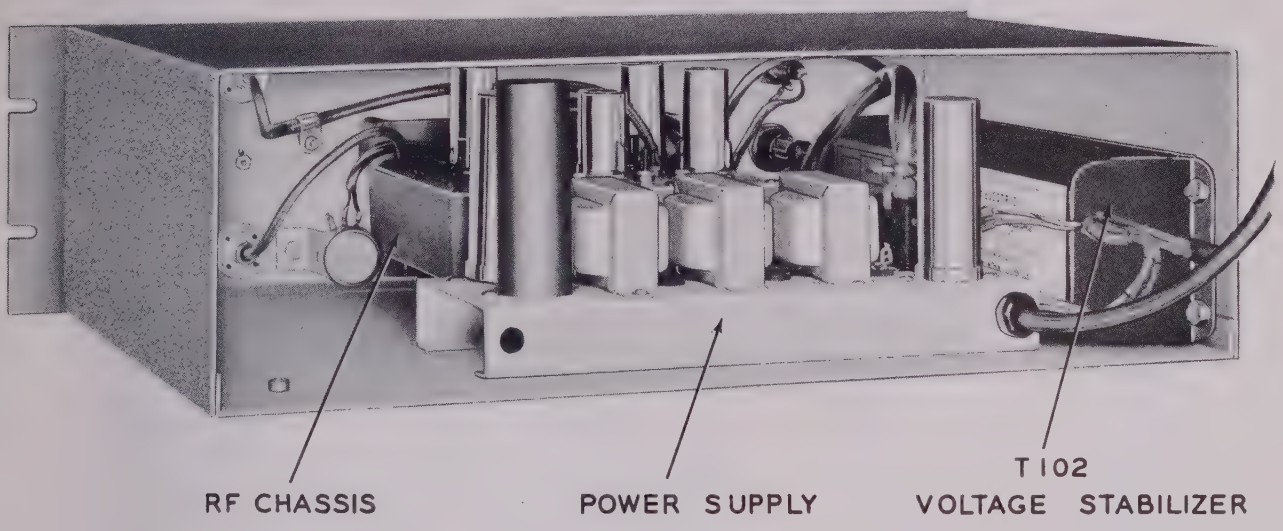


Fig. 7 Rear View of 207-F In Cabinet

SOCKET VOLTAGE CHART

All voltages are dc unless otherwise specified.
All dc measurements are made with 20,000 ohms per volt voltmeter.
All ac measurements are made with 1000 ohms per volt ac voltmeter.
Conditions for measurement:

a. Measurements made with respect to ground.
b. No input signal applied to the Univerter.

Pin No.	1	2	3	4	5	6	7	8
V-101 (6AB4)	170	0	0	5.3	0	1.85	.38	
V-102 (6AK5)	0	2.8	5.18 (ac)	0	167	130	2.8	
V-103 (6AK5)	0	2.5	5.18 (ac)	0	169	115	2.8	
V-104 (6AH6)	—1.13	0	5.25 (ac)	0	170	127	1.25	
V-105 (6C4)	179	0	0	5.3 (ac)	179	9.4	0	

VII. LIST OF REPLACEABLE PARTS

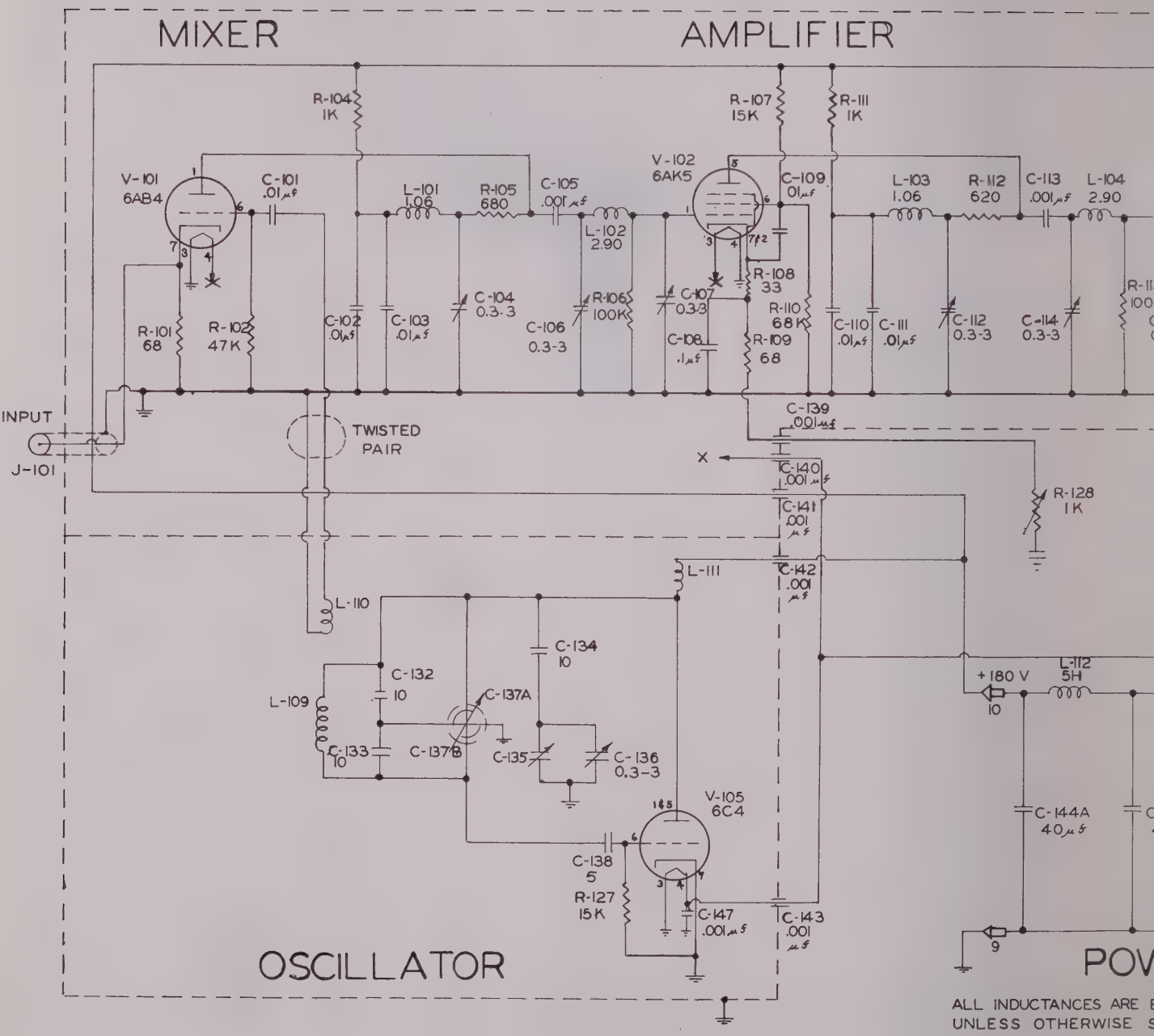
The following parts are replaceable. After replacement it is desirable to make the checks and adjustments described in Section V.

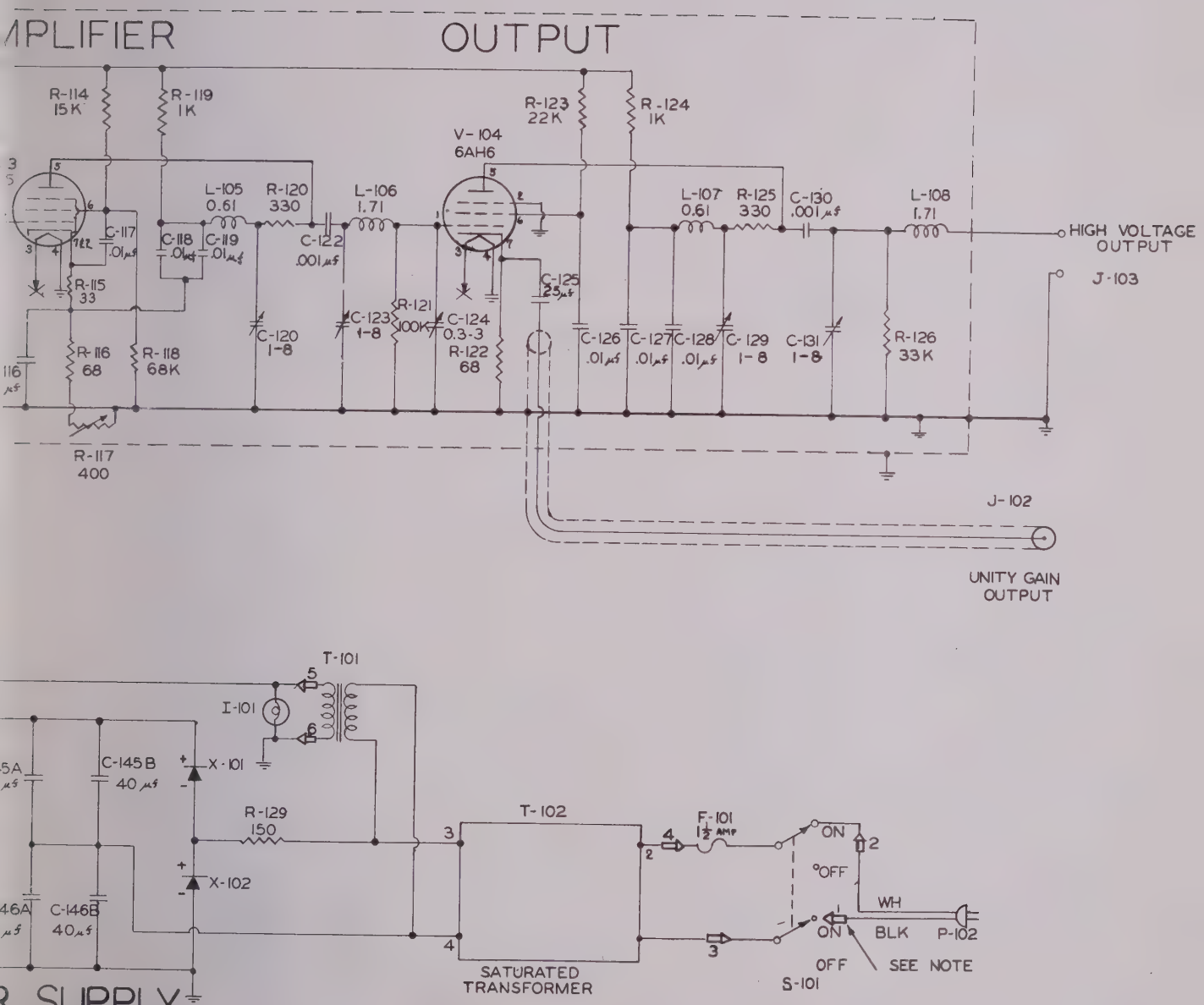
TYPE 207-F UNIVERTER ELECTRICAL COMPONENT PARTS LIST

Circuit Symbol	Value	Description	BRC Part No.
C-101	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-102	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-103	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-104	.3-3μf	Capacitor, Variable Pyrex Tubular	84088
C-105	1000μμf	Cacacitor, Fixed +80%—20% 600V	82306
C-106	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-107	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-108	.1μf	Capacitor, Fixed +30%—20% 200V	83019
C-109	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-110	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-111	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-112	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-113	1000μμf	Capacitor, Fixed +80%—20% 600V	82306
C-114	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-115	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-116	.1μf	Capacitor, Fixed +30%—20% 200V	83019
C-117	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-118	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-119	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-120	1-8μμf	Capacitor, Variable Pyrex Tubular	84089
C-121	5μμf	Capacitor, Fixed ±5% Ceramic	82032
C-122	1000μμf	Capacitor, Fixed +80%—20% 600V	82306
C-123	1-8μμf	Capacitor, Variable Pyrex Tubular	84089
C-124	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-125	.25μf	Capacitor, Fixed +30%—20% 200V	83023
C-126	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-127	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-128	.01μf	Capacitor, Fixed +80%—20% 600V	82428
C-129	1-8μμf	Capacitor, Variable Pyrex Tubular	84089
C-130	1000μμf	Capacitor, Fixed +80%—20% 600V	82306
C-131	1-8μμf	Capacitor, Variable Pyrex Tubular	84089
C-132	10μμf	Capacitor, Fixed ±2% NPO 500V Ceramic	82011
C-133	10μμf	Capacitor, Fixed ±2% NPO 500V Ceramic	82011
C-134	10μμf	Capacitor, Fixed ±2% NPO 500V Ceramic	82011
C-135	3.25-4.25μμf	Capacitor, Variable Frequency Increment	
C-136	.3-3μμf	Capacitor, Variable Pyrex Tubular	84088
C-137	A1. 7-3. 3μμf B1. 7-3. 3μμf	Capacitor, Variable (butterfly)	84011
C-138	5μμf	Capacitor, Fixed ±5% NPO 500V Ceramic	82003
C-139	.001μf	Capacitor, Fixed Button Type ±10%	82307
C-140	.001μf	Capacitor, Fixed Button Type ±10%	82307
C-141	.001μf	Capacitor, Fixed Button Type ±10%	82307
C-142	.001μf	Capacitor, Fixed Button Type ±10%	82307
C-143	.001μf	Capacitor, Fixed Button Type ±10%	82307
C-144	A40μf B40μf	Capacitor, Fixed Electrolytic 200V	83094
C-145	A40μf B40μf	Capacitor, Fixed Electrolytic 200V	83093

TYPE 207-F UNIVERTER ELECTRICAL COMPONENT PARTS LIST — *Continued*

Circuit Symbol	Value	Description	BRC Part No.
C-146	A40μf B40μf	Capacitor, Fixed Electrolytic 200V	83094
C-147	.001μf	Capacitor, Fixed Button Type ±10%	82307
F-101	1-½ amp	Fuse	93250
I-101	6.3V, 0. 15a	Lamp, Incandescent	90904
J-101		Jack, BNC, 1 Female Contact	89065
J-102		Jack, BNC, 1 Female Contact	89065
J-103		Jack, Crystal Holder Type	300286
L-101	1.06μh	Choke, ±3%	300326
L-102	2.90μh	Choke, ±3%	300325
L-103	1.06μh	Choke, ±3%	300326
L-104	2.90μh	Choke, ±3%	300325
L-105	0.61μh	Choke, ±3%	300323
L-106	1.71μh	Choke, ±3%	300322
L-107	0.61μh	Choke, ±3%	300323
L-108	1.71μh	Choke, ±3%	300322
L-109, 110	Special	Oscillator and Pick-up Coil Assembly	301321
L-111	5μh	Choke,±5%	300327
L-112	5h	Choke	85412
L-113	5 h	Choke	85412
P-101		Plug, 8 Male Contacts	94147
R-101	68Ω	Resistor Fixed, ½W ±5%	80057
R-102	47KΩ	Resistor Fixed, ½W ±5%	80460
R-103	330Ω	Resistor Fixed, ½W ±5%	80172
R-104	1KΩ	Resistor Fixed, ½W ±5%	80148
R-105	680Ω	Resistor Fixed, ½W ±5%	80138
R-106	100KΩ	Resistor Fixed, ½W ±5%	80517
R-107	15KΩ	Resistor Fixed, ½W ±5%	80336
R-108	33Ω	Resistor Fixed, ½W ±5%	80032
R-109	68Ω	Resistor Fixed, ½W ±5%	80057
R-110	68KΩ	Resistor Fixed, ½W ±5%	80549
R-111	1KΩ	Resistor Fixed, ½W ±5%	80148
R-112	620Ω	Resistor Fixed, ½W ±5%	80191
R-113	100KΩ	Resistor Fixed, ½W ±5%	80517
R-114	15KΩ	Resistor Fixed, ½W ±5%	80336
R-115	33Ω	Resistor Fixed, ½W ±5%	80032
R-116	68Ω	Resistor Fixed, ½W ±5%	80057
R-117	400Ω	Resistor Variable, 2W	81116
R-118	68KΩ	Resistor Fixed, ½W ±5%	80549
R-119	1KΩ	Resistor Fixed, ½W ±5%	80148
R-120	330Ω	Resistor Fixed, ½W ±5%	80172
R-121	100KΩ	Resistor Fixed, ½W ±5%	80517
R-122	68Ω	Resistor Fixed, ½W ±5%	80057
R-123	22KΩ	Resistor Fixed, ½W ±5%	80472
R-124	1KΩ	Resistor Fixed, ½W ±5%	80148
R-125	330Ω	Resistor Fixed, ½W ±5%	80172
R-126	33KΩ	Resistor Fixed, ½W ±5%	80461
R-127	15KΩ	Resistor Fixed, ½W ±5%	80336
R-128	1KΩ	Resistor Variable, 2W	81119
R-129	150Ω	Resistor Fixed, 20W ±5%	80090


MIXER
AMPLIFIER
OSCILLATOR
R-104 1K
R-107 15K
R-111 1K
V-101 6AB4
C-101 .01μf
L-101 1.06
R-105 680
C-105 .001μf
V-102 6AK5
C-109 .01μf
L-103 1.06
R-112 620
C-113 .001μf
L-104 2.90
L-102 2.90
R-108 33
C-107 0.3-3
R-110 68K
R-101 68
R-102 47K
C-102 .01μf
C-103 .01μf
C-104 0.3-3
C-106 0.3-3
R-106 100K
C-108 .1μf
R-109 68
C-110 .01μf
C-111 .01μf
C-112 0.3-3
C-114 0.3-3
INPUT
J-101
TWISTED PAIR
C-139 .001μf
X
C-140 .001μf
C-141 .001μf
R-128 1K
C-142 .001μf
L-111
L-110
C-134 10
C-132 10
L-109
C-137A
C-133 10
C-137B
C-135
C-136 0.3-3
V-105 6C4
C-138 5
R-127 15K
C-147 .001μf
C-143 .001μf
+180 V
10
L-112 5H
C-144A 40μf
9
POW
ALL INDUCTANCES ARE
UNLESS OTHERWISE
"K" = 1,000 ; "M" = 1,
POWER SUPPLY
POINT OF SYMB
COMING FROM PL



SED IN MICROHENRIES, CAPACITANCE IN MICRO MICRO FARADS, AND RESISTANCE IN OHMS
ED

S PLUG P-101
ICATES DIRECTION OF WIRE
ONG INTO CABLE.

ig. 8 . Schematic Wiring Diagram of 207-F Univerter

APPENDIX

LIST OF ILLUSTRATIONS

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APPENDIX

OUTPUT CONNECTIONS

A. The method of connecting the load to the 202-F Signal Generator or to the 207-F Univerter must be considered to insure proper interpretation of results, and the following discussion is offered as an aid to the user.

It is convenient to represent a signal source in terms of its open circuit voltage and internal impedance.* Thus a signal source or an antenna can be represented as in Figure 1. For simplicity, only the case where source and load impedance are resistive will be considered.

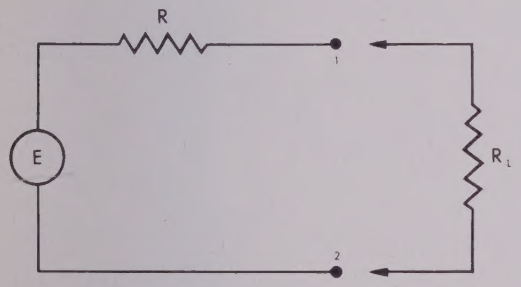

Fig. 1 Signal Source Representation

E — open circuit voltage
R — impedance looking into terminals 1 and 2
R_L — load impedance

For purposes of rating sensitivity, the input to a receiver might have been defined initially either as the open circuit source voltage E or the voltage actually across the receiver's terminals. The Institute of Radio Engineers has established the former method as standard and defined receiver input in terms of the open circuit voltage of the source.**

The impedance of the signal source employed to test receivers should be equal to the impedance of the antenna with which the receiver is designed to operate. Note that in this case the voltage actually across the receiver terminal is $\frac{E}{2}$ (Receiver input impedance equal to source impedance.)

**General Radio Experimenter, Vol. XXI, No. 1, June, 1946.*

***The Institute of Radio Engineers, Section 4.01.01, 1947, Standards on Radio Receivers, The Institute of Radio Engineers, Section 4.01.01, 1948, Standards on Television.*

B. *Accessories* for physically connecting the instrument to the load are described in the following:

1. *501-B Output Cable (supplied with 202-F)*

A 501-B Cable attached to the 202 or 207 is illustrated by Figure 2, where R_2 is the 50 ohm termination of the 501-B cable. The equivalent circuit (Figure 3) is readily determined by applying Thevinin's theorem. This arrangement is recommended for general use where it is desirable to connect the 202 or 207 output to an input circuit of relatively higher impedance than 25 ohms. The attenuator of the 202 will read the output directly.

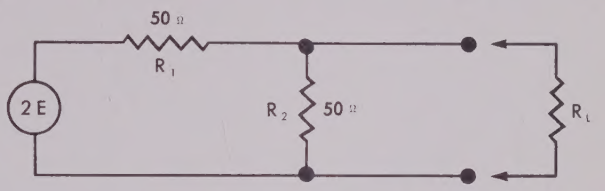

Fig. 2 Output Circuit of 202-F or 207-F with 501-B Output Cable Attached,

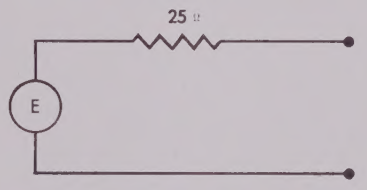

Fig. 3 Equivalent Output Circuit of 202-F or 207-F with 501-B Output Cable Attached

E — 202 attenuator dial reading
R_1 — internal resistance of 202 or 207
R_2 — 501-B cable termination
R_L — load impedance

2. *505-B, 6db Pad*

This pad is used as a dummy antenna in testing unbalanced receivers with a 50-ohm input as shown in Figure 4.

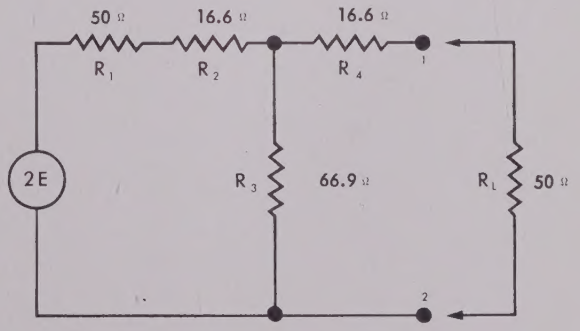

Fig. 4 505-B T-Pad as Dummy Antenna for Receiver

E — 202 attenuator dial reading
R_1 — internal resistance of 202 or 207
R_2 — pad resistance

R_3 — pad resistance
R_4 — pad resistance
R_L — load impedance

The open circuit voltage appearing across terminals 1 and 2 is by Ohms law (equation 1) equal to E, half of the source voltage. Applying Thevinin's theorem the equivalent circuit of Figure 5 is obtained, and thus the attenuator dial of the 202 reads receiver sensitivity directly for the assumed standard output.

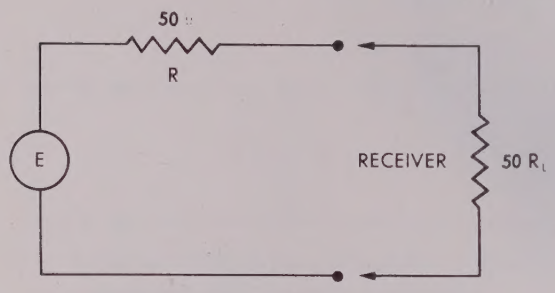

Fig. 5 Equivalent Circuit of a 505-B T-Pad as an Antenna

3. *509-B 20 db T-Pad (Supplied with the 207-F)*

This pad is useful where signal levels are required which are low compared to the constant noise level of the 207. Since the noise level of the 207 is constant, the signal to noise ratio varies directly as the signal level. Therefore, with low output voltage the signal to noise ratio may be improved by increasing the input voltage and attenuating the output. For practical purposes the 20 db pad is useful at output levels below 5,000 microvolts for the 202-F. The signal applied to a 50-ohm load may be found by dividing the 202 attenuator dial reading by ten.

The 509-B pad, like the 505-B, may be used as a dummy antenna except that the measure of receiver sensitivity (equivalent source voltage) is one-fifth the 202 attenuator dial reading.

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